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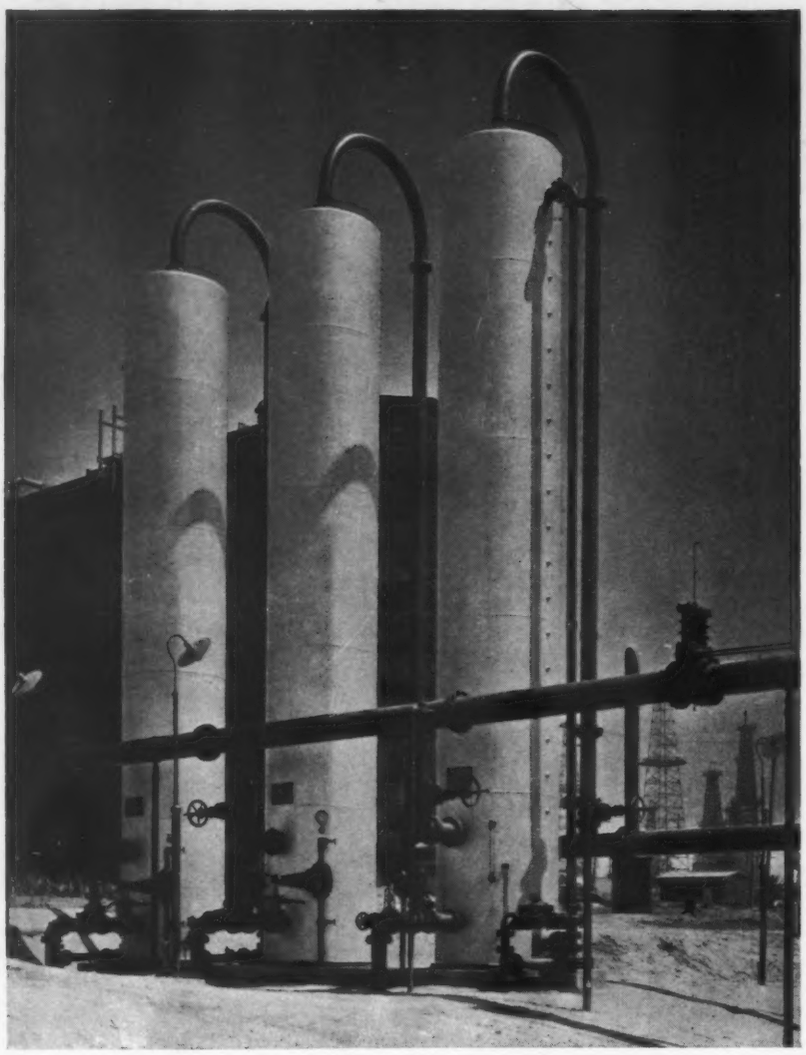

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Vol. 8, No. 1

JANUARY, 1929

GRADY TRIPLETT, *Editor*

GEORGE REID, *Associate Editor*

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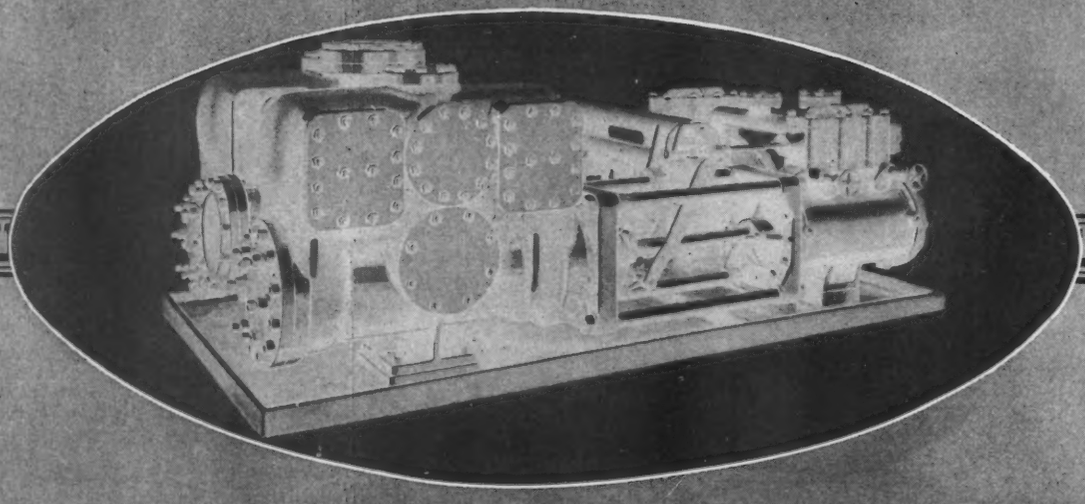

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New Year Demands Old Practice

IT is a New Year but to the refining industry it demands a repetition of old practices. The practice, in fact, is not very old. Refiners learned restraint only in 1928.

The prospect for 1929 is for more crude oil, for Oklahoma, Texas and California are contributing more oil fields to augment the discoveries of 1928.

What the refining industry did for itself and for all of the industry in 1928 is a creditable record. Plant throughput was for a great part of that year held close to requirements.

That is the demand for 1929. The task will be more difficult in 1929. The prospect is for a greater supply of raw material. The prospect of greater supply, leaves the possibility of a lower cost. Low material cost is a temptation to the manufacturer.

But the automobiles and other consuming units will require an increase in finished products that can be determined now. The average increase for the past 10 years, is an index that is safe to follow.

Demand should be the guiding hand for the refining industry in 1929. It will take courage to conduct plant activity on this basis, while ample crude oil is available at possibly lower prices.

The refining industry should practice restraint for itself. Without it, prices of finished products will fall and with them will fall profits. Restraint is a selfish matter with the refining division of the petroleum division. Without this sort of selfishness, profit will suffer.

For the whole petroleum industry, the restraint of the refiner is essential. An industry learns only as men learn. Men learn after the fashion of animals. When hurt they give up a practice.

The petroleum industry will learn to halt oil production when it has been hurt through oil production. With the refining plants of the United States taking only the crude oil that will yield the desired amount of finished products, the producing division will be hurt through its folly of production.

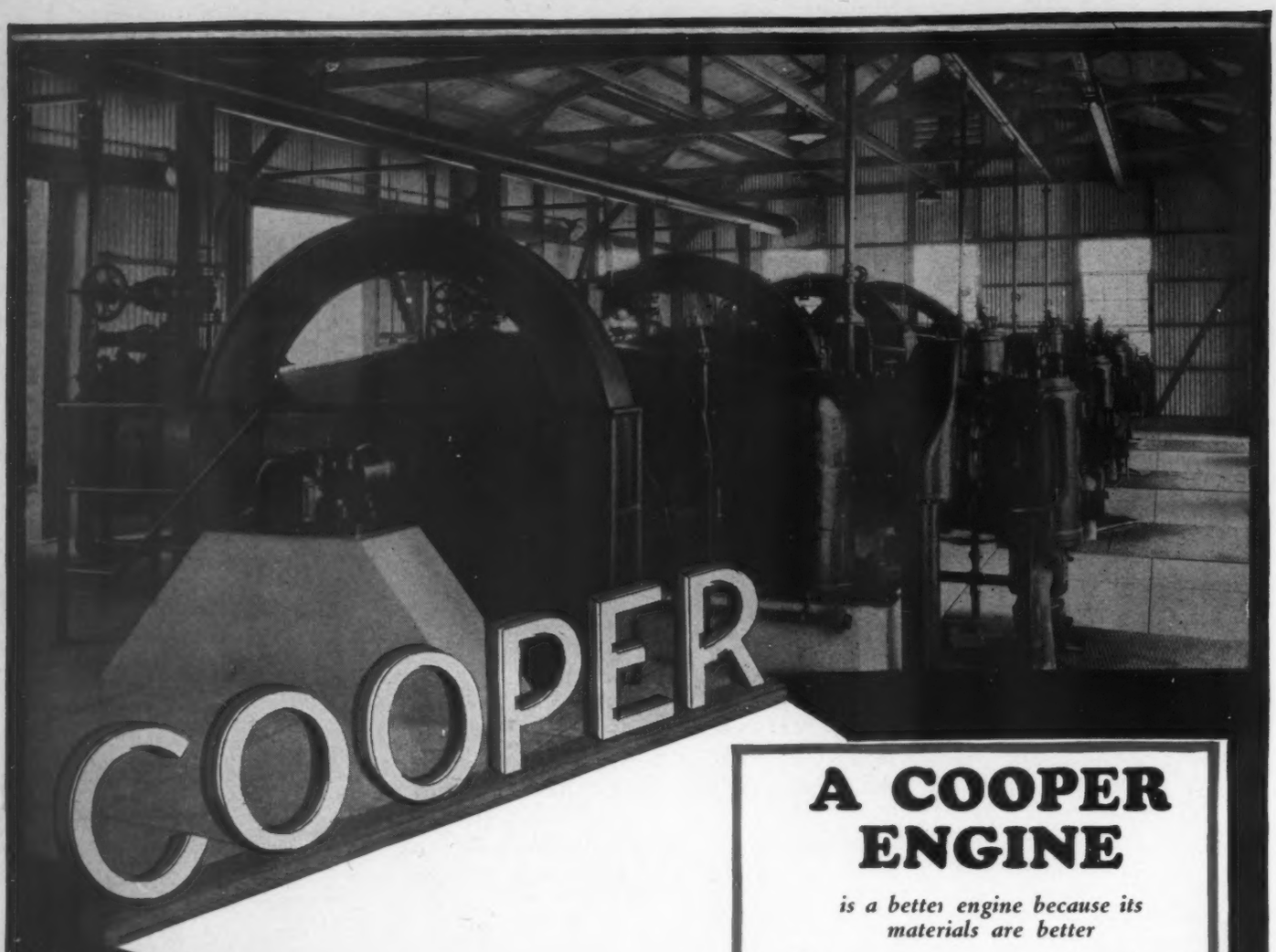
Conservation is having its greatest day in the affairs of oil. But the surest road of sensible drilling is lack of a market for oil. Somewhere there is an end of buying and building storage.

It is the duty of the refining industry to take only as much oil as the market requires. With that practice continued there will be an end to unnecessary drilling.

Profits were great to the petroleum industry in 1928. The refining division played the major role in assuring these profits.

What the balance sheet of the petroleum industry shows at the end of 1929 will be determined largely by what the refining division does in 1929.

Grady Gilbert



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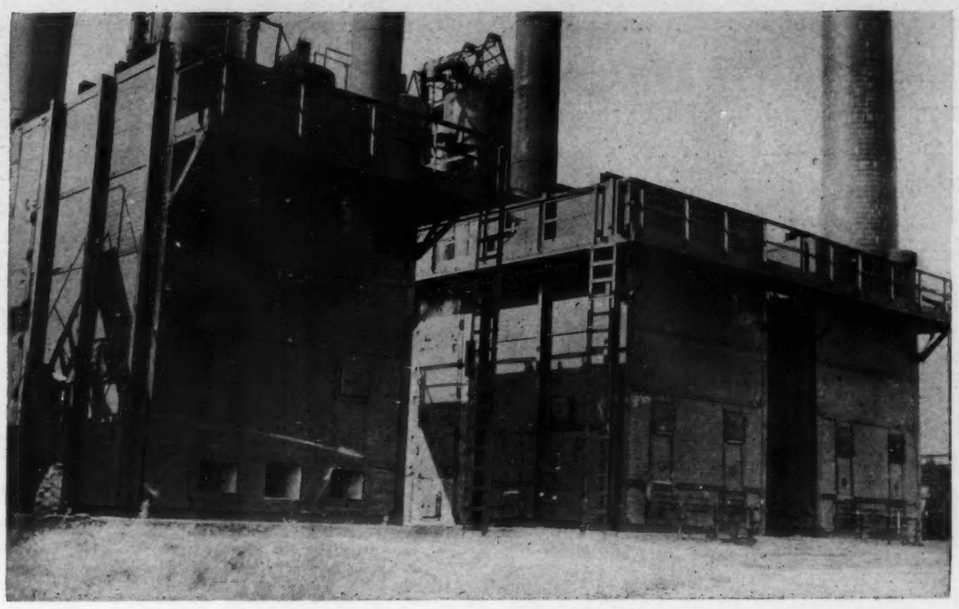
The illustration shows Getty Gasoline Company's new gasoline plant, containing four Cooper Type 80 single gas engines in the Long Beach, California, field.



Tube Still Battery at the plant of Barnsdall Refineries Inc., Okmulgee, Oklahoma

Preheaters at Okmulgee Plant Remove All Gasoline Fractions

By GEORGE REID
Associate Editor

BY preheating crude charged to the Barnsdall Refineries, Inc., plant at Okmulgee, Oklahoma, through a series of both vapor and liquid heat exchangers, practically all of the gasoline content in the charged oil is vaporized and removed before it is fed into the pipe still coils.

Through the utilization of efficient preheating equipment, and the tube still, the Barnsdall installation effects the vaporization of 85 per cent. of the crude charged, but the tube still does not handle the additional load of gasoline originally in the oil. This type of distillation equipment exemplifies the modern trend in refinery engineering whereby as much of the crude is distilled outside of the heating element proper as is economically possible by taking advantage of existing heat which was formerly wasted.

In addition to decreasing the load or volume of oil which the pipe still must heat to the point of vaporization, the insertion of vapor heat exchange equipment on the vapor lines also tends to decrease the load, or the work, of the condenser equipment, and further, lowers the cooling water requirements.

The skimming plant distillation equipment at the Okmulgee plant of the Barnsdall Company consists at present of two 4-inch tube stills. Each of these stills contains 1300 feet of tubes. The rated capacity of each still is 4000 barrels daily, from which they will distill 62 per cent of the charge. Present operation methods, however, consist of a normal charging rate of 2500 barrels daily and taking 85 per cent of the charge overhead and reducing the fuel oil residuum to 9 to 12 A. P. I. gravity. All of the tube stills are Foster type. The third unit is now being altered through the addition of fractionating preheating and control equipment of later modern type, under the supervision of Gordon T. Granger, refinery superintendent, who designed the tower system now under discussion.

In these units Mr. Granger's design calls for the preheating of the crude to 400-410 F. by interchange with hot vapors and residuum, through six interchangers in series. Cold crude at the pump house is handled by a Dean centrifugal pump which is driven by a Dean-Wait Steam turbine. On the same shaft and driven by single the turbine is a second centrifugal pump which circulates gasoline over the bubble tower as a reflux media.

The cool crude pump is automatically controlled and discharges its oil directly to a series of vapor heat exchangers on the vapor line between the top of the tower and the condenser coils. All of the exchange equipment is Griscom-Russell type. The fresh crude passes through the vapor heat exchangers where it picks up some heat and partially cools the gasoline vapors which are en route to the Sterling condenser sections, and then is conducted to the top of the bubble tower, where it passes through a reflux condenser section. From this point it is conducted through a well insulted line to the bottom of the tower equipment where it passes counter-current to hot residuum in a series of two liquid exchangers. By this

time it is pre-heated to 400-410 F. and ready for flashing to remove the vaporized gasoline fraction.

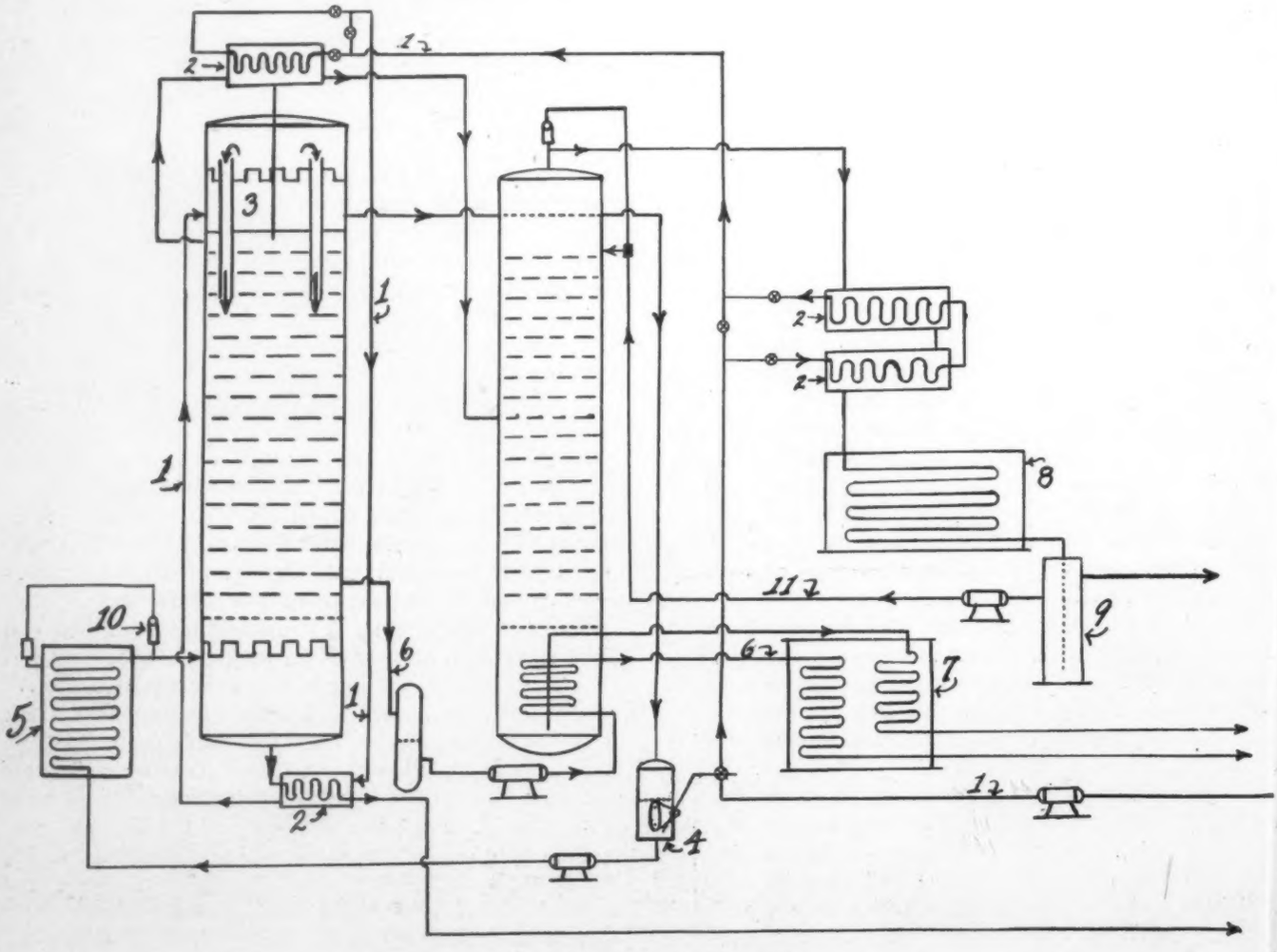
FLASHING SYSTEM

The flash section as designed by Mr. Granger and company engineers is somewhat different from the usual flash chamber in that it is incorporated as an integral part of the first bubble tower. The preheated crude is taken from the final exchanger again to nearly the top of the first bubble tower where it is expanded into a flashing chamber located at that point. This chamber is closed to the rest of the fractionating columns except for two 6-inch down-spouts. It is equipped with a "breaker" tray at about the middle of the section. The details of this type of flashing section are indicated in the accompanying flow chart diagram of the plant. Crude enters the flashing section under pressure of about 8 pounds per square inch and the pressure is reduced to about 20 pounds by the expansion and removal of the vaporized portion.

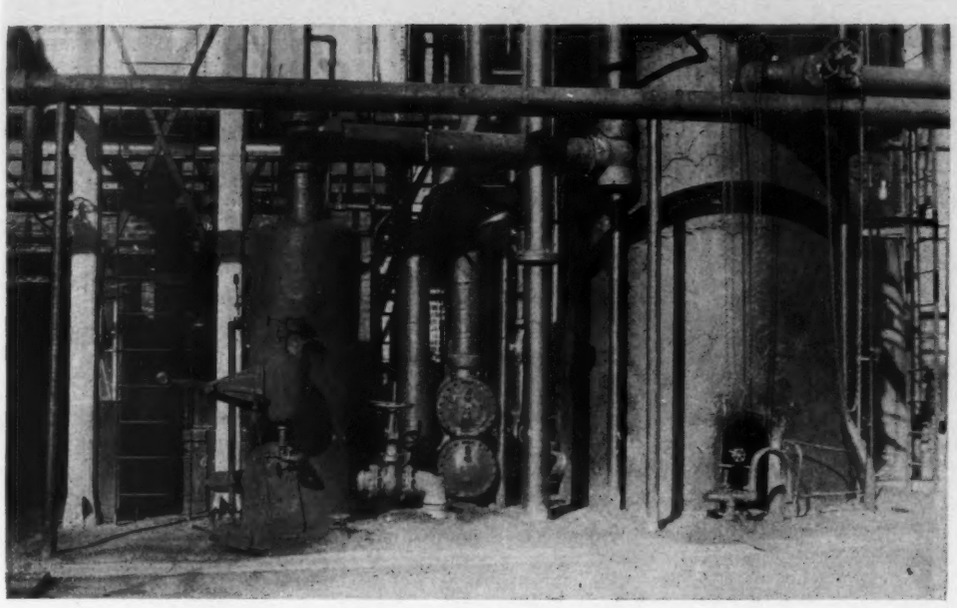
All of the gasoline vapors liberated at this point are conducted downward through the two six-inch down spouts into the bubble tower below at about three trays down, where they are caused to mix with the rising vaporized portions of the crude oil which have passed through the pipe still heating element. The combined steam of gasoline and kerosene vapors pass upward and out of the tower through the reflux condenser section where they partially preheat the incoming crude before passing into the second bubble tower at about the seventh bubble tray.

Following the crude flow from the flashing chamber when the gasoline is removed, it flows out of the opposite side of the separating section and down to a small accumulator tank near the crude charging pumps. In this small drum, the reduced crude accumulates for charging to the pipe still coils. The fresh crude charged through the exchanger equipment is usually 38-39 gravity oil, but by the time it reaches this accumulator or "oil pot" the gravity has been reduced to 28-30 through the removal of practically all of the gasoline content.

The crude level in the "pot" is under automatic control, which control regulates the flow of fresh oil through the exchanger equipment from the centrifugal charging pump. The hot or reduced crude in the accumulator tank is charged to the pipe still by a "hot oil" charging pump. Any vapors evolved in the accumulator tank are vented back into the first bubble tower. The second pump handles oil about 400 degrees F.



Flow Chart, Barnsdall Okmulgee Plant



Accumulator tank for reduced crude. Liquid level control device regulates volume of crude charged to the heat exchanger equipment.

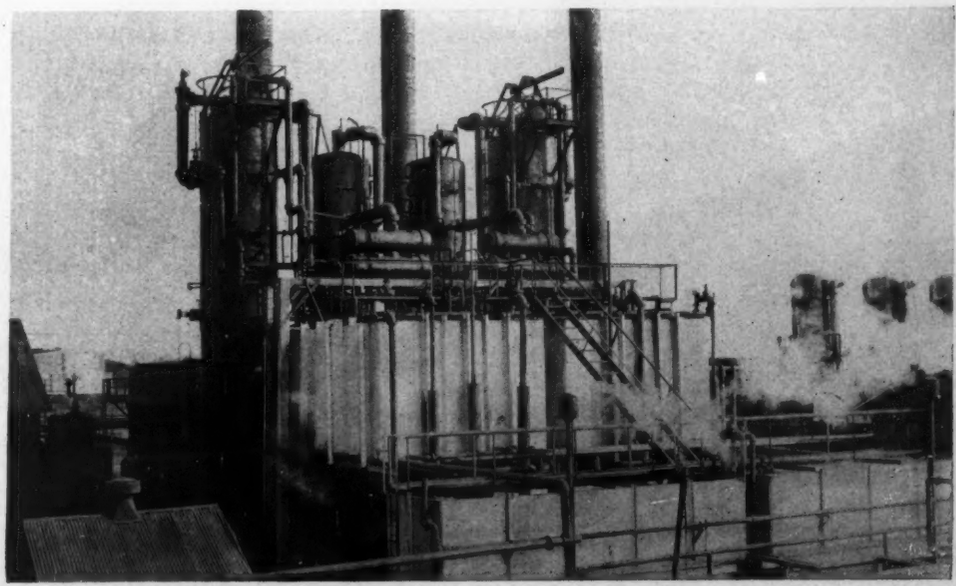
BUBBLE TOWER SYSTEM

Leaving the pipe still coil the heated oil and vapors pass into the bottom of the bubble tower where the residuum is separated in the lower compartment to pass out through the residuum heat exchanger equipment, to cooling equipment and to storage. The vaporized portion, gas oil and kerosene, passes upward through the tower. At a point above the lower or evaporator section of the tower, the gas oil fraction is taken off as a side stream from this tower. Kerosene vapors pass upward to combine with the gasoline vapors which come downward from the flashing section in the top of the tower, and the combined vapors pass through the reflux condenser section and over into the second bubble tower, entering at about the seventh tray, as previously mentioned. The bubble towers and tower system are the design of company engineers.

The second bubble tower has a reboiler section at the bottom. Hot gas oil from the central compartment of the first tower is employed to reboil the kerosene in the bottom of the second tower. The gas oil flows from the first tower into a small accumulator tank. At this point it is picked up by a controlled pump and discharged through the reboiler section of the second tower, passing through nested coils, and being conducted to cooling section in the condenser box, and to storage.

Kerosene is removed from the bottom of the second bubble tower of the series, flowing through the cooling sections as it accumulates in the reboiler, and to storage. The gasoline vapors pass upward through the tower rising against a descending reflux media, which is finished gasoline taken from the same tower. It is Mr. Grangers' policy to reflux over his towers only the finished product from that tower for he believes that the refluxing agent should be as nearly similar to the product being fractionated as possible. To simplify this work and to assure the use of gasoline direct from the bubble trays of the tower a reflux leg was designed which is similar to the ordinary water trap or leg, which is inserted in the gasoline at the point where it leaves the receiving house flowing to run down tank storage. From this source is secured the gasoline for pumping back over the bubble tower. The gasoline vapors leaving the top of the second bubble tower are finished to end point specifications. They pass through the two vapor heat exchangers, as previously mentioned and are partially condensed at that point, as well as serving to preheat the incoming fresh crude.

The units are very flexible and gasolines can be produced to meet a number of varying specifications. The bubble towers are equipped for the removal of side streams if such are desired. Brown Pyrometers record the important temperatures, and a twelve point temperature indicating instrument is provided for watching the less important temperatures. Automatic recording temperature controllers control the fractionation in the columns. Temperature control is based upon the 90 per cent. boiling point of the gasoline to be made rather than on the gasoline end point. To secure the desired 90 per cent. point, temperature at the top of the tower is held about 50 degrees below the desired test temperature.



Rear view showing fractionation equipment and vapor heat exchangers for preheating crude. Reflux condensers shown at top of bubble towers.

Indian Refining Company Treats Cracked Gasoline Before Storing

By GEORGE REID
Associate Editor

TREATING, so far as cracked distillates are concerned, began at the Indian Refining Company, Lawrenceville, Illinois, in 1920, when the first commercial Cross cracking unit ever constructed was placed in operation. The problem of chemical refinement of cracked gasolines became more difficult in after years when the second Cross unit was added, then later the Fleming units, now abandoned, and the four Dubbs units. At present 12 cracking units having an aggregate rated capacity of 12,000 barrels daily produce 59 to 60 per cent. gasoline from the fresh charging stock sent to the cracking department. The operation of these cracking units in tandem series was discussed in detail at a previous writing.

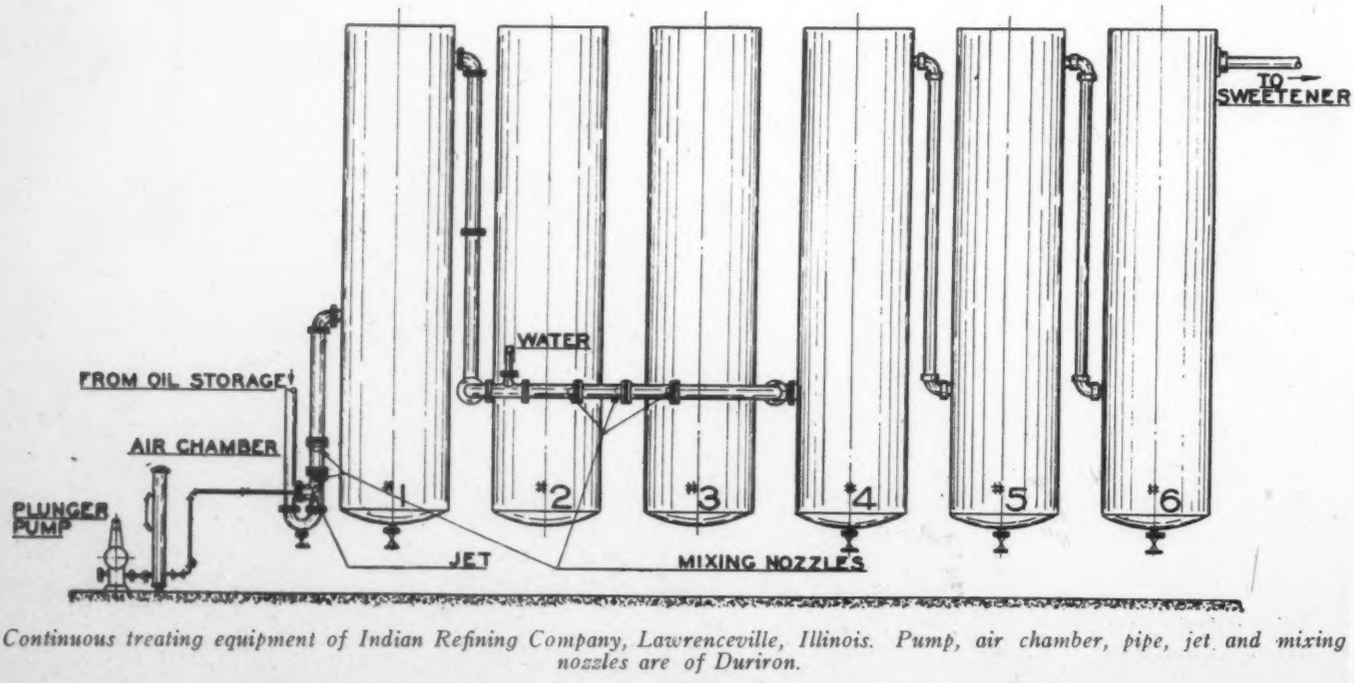
At the Indian Refining Company plant it was devised to produce a cracked gasoline of good mileage qualities, volatile without the addition of light blending stock, low in gums, stable and high in anti-knock value. Operation of the individual cracking unit and of the whole cracking department contributes much to securing these characteristics, and operation of the units must be followed by the proper chemical treatment of the finished gasoline and this as the lowest possible cost per barrel.

After about four years of research and experimentation the company began the operation of its cracking units in banks, or tandem. At the same time the practice of immediate treatment of the gasoline was begun. This treatment method replaces the older method of conducting cracking unit condensates to storage where they were held until such time as the central treating plant could handle them. Experimentation has shown conclusively that within very few hours after condensation of the cracked gasoline the chemical changes so detrimental to color and odor of the finished fuel begin and that these changes progress rather rapidly.

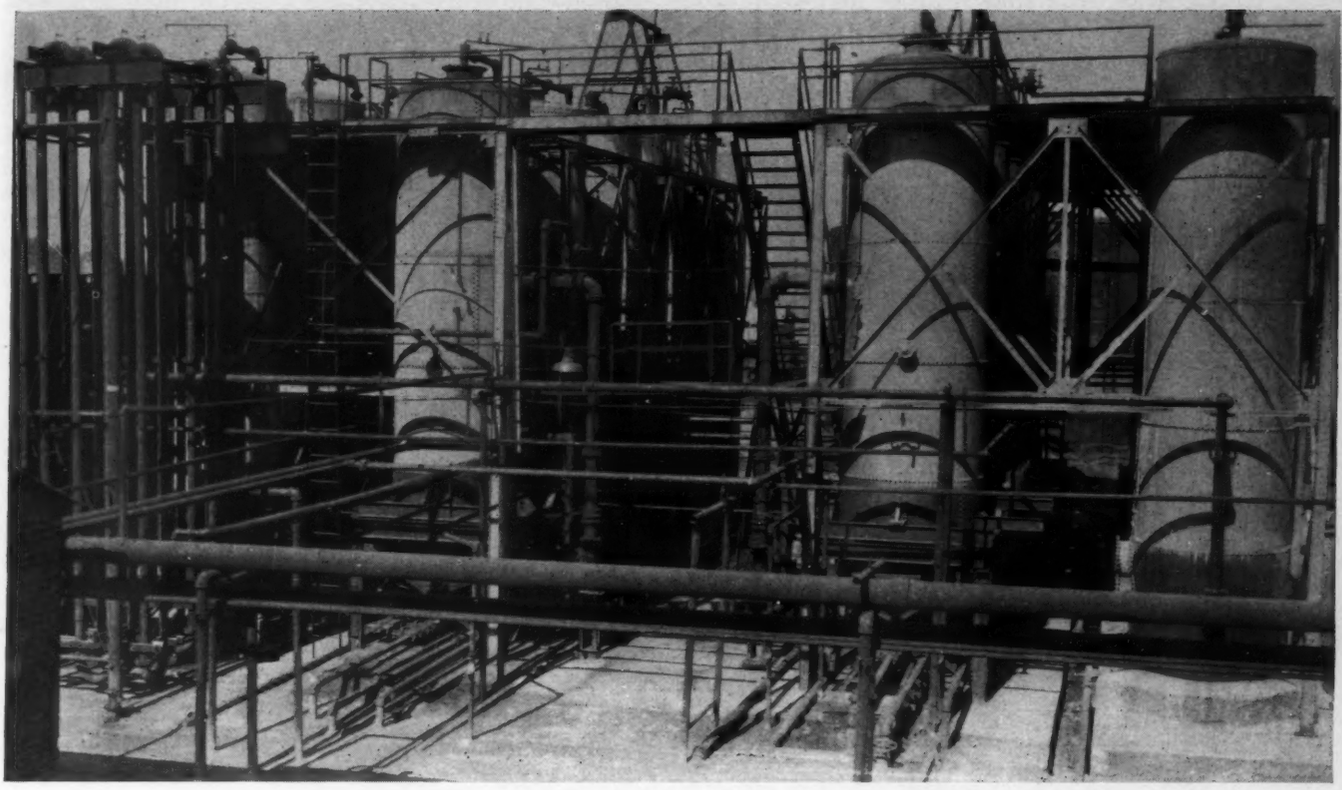
A great deal of experimentation was carried on to determine some method or process which would prevent the starting of such detrimental chemical changes and effect the stabilization of the gasoline. The method finally adopted consists of giving the cracked gasoline derived direct from the units a preliminary treatment with caustic solution as soon as possible after condensation in the coils.

TREATING BEGINS IMMEDIATELY

All of the cracked gasoline produced direct from the cracking units has an end point of 440 F. and after chemical treatment it is redistilled, yielding a finished gasoline requiring no further treatment having an end point of 400 to 405 F. It is given its first chemical treatment at the cracking units in a centralized treating system, continuous type, located in that part of the plant given over to cracking. While the gasoline is "live" and still warm—at or near the temperature of condensation



Continuous treating equipment of Indian Refining Company, Lawrenceville, Illinois. Pump, air chamber, pipe, jet and mixing nozzles are of Duriron.



View of the four continuous treating systems where all pressure products and straight run gasoline is treated at the Indian Refining Company's Lawrenceville plant.

—it is immediately passed through this alkaline treating solution and washed with water. The system consists of nine treating columns or drums, 40 inches by 20 feet in dimensions, first passing through the caustic solution end then through the water washing columns.

All of the gasoline from the 12 units is pumped direct to what is called surged tanks, which are horizontal containers located at the treating plant. From these it is circulated through the treating system about as fast as it is produced by the cracking units.

This practice prevents the starting of any deleterious chemical reactions within the gasoline itself. It also effects the immediate removal of any hydrogen sulphide in the condensates, and further, it effects the removal of some sulphides and gums. Dr. Frank Fritts, executive vice-president of the company, estimates that the caustic is twice effective at this stage, and removes about twice as much impurities, thus contributing much to the stabilization of the finished gasoline.

The 440 end point cracked gasoline, after its caustic treatment can then be stored, and usually may be stored for long periods without suffering any ill effects due to chemical changes. The method is preferable to storing these distillates in tanks on top of a layer of alkaline solution.

From storage the cracked gasoline is taken direct to the continuous acid treating plant. For about three years the Indian Refining Company has been treating all of its pressure products in continuous systems as the value of intimate and immediate contact of acid and oil was recognized at that time. By applying the acid completely, every particle of the oil being touched, much smaller amounts of acid could be used and more effectively than former practice where batch agitation and settling was necessary. In addition, to a marked lowering of acid requirements, the nozzle mixing and continuous operation effects the immediate removal of the acid in the first settling drum. Since the diolefin series is actually the only objectionable series in the oil, and since the olefins and naphthenes are of value from an anti-knock standpoint, the acid is given a thorough mixing with the oil and removed as quickly as possible.

DISTILLED SECOND TIME

The four treating systems consisting of six treating drums each was among the first to employ Duriron equipment for handling acid in this country. The working equipment which has been in service for about three years and which is made of Duriron consists of two complete units each made up of a vertical mixing tube in which two mixing nozzles are used for mixing acid with the oil. The feed of acid is controlled by proportioning pumps made of the same metal. These proportioning pumps are direct motor driven through variable speed drives and are set to deliver a given quantity of acid under pressure as high as 75 pounds per square inch and within less than one per cent. of absolute accuracy. An ample air chamber of the same metal is placed in the discharge line just beyond the pump so that a nonpulsating flow is obtained at the elbow jet. There are three such pump units, one each for the two acid treating systems, and a third is held in reserve as auxiliary equipment. Wherever there is possibility of acid corrosion to parts, such as pumps, pipe, fittings, valves, mixing nozzles, etc., Duiron has been used.

The treating systems handle about 200 barrels of gasoline per hour, contacting acid through the nozzles

in the mixing tubes, separating it in the first drum and washing with water through a series of jets or nozzles between the first and second drum. The remaining drums are employed for caustic neutralization, or doctor treat, washing and settling.

After this acid treating and neutralization the 440 end point is taken to the stills and redistilled. This procedure is regulated to give a gasoline of close fractions having an initial boiling point as it comes from the stills of 94 F., 90 per cent. at 355-360 F. and an end point of 400 to 405 F. This product is stored and kept separate from the straight run gasoline produced by the plant and marketed through the company's stations as premium gasoline. In order to meet the demand the company plans to increase its cracking facilities by the addition of at least one more of the new large type Cross cracking units.

After redistillation the 400 end point gasoline requires no further chemical treatment, as a rule. When required, it is given a caustic wash only. This ease of handling the redistilled product is attributed to the fact that it is not permitted to go to storage as it comes from the cracking unit, but is given a preliminary treatment with caustic immediately after condensation. Company executives state that the Cross and Dubbs gasoline produced at the plant can be prepared to have an anti-knock value higher than their requirements of 40 per cent. benzol equivalent, but it is held at this figure in order to avoid gum troubles. This is in line with the practice of the majority of refineries in this country at present.

Controlling Distillation Efficiency When Using Steam

By W. R. HOUNSELL
Superintendent, Houston Oil Company

SINCE so many pipe-stills and highly efficient fractionating columns have now been installed in many of our refineries, we are becoming accustomed to the use of a number of engineering and physical formulae, without which our efficiency programs could not proceed very far.

Chemists, engineers and physicists have propounded and compounded their ideas and general knowledge; have designated certain pieces of old apparatus, as belonging to the scrap-heap, and have installed some new-born pieces of efficiency to take their places. As a result, we find ourselves no longer handicapped, and able to keep abreast of refinery progress.

Due to intimate contact with designers, and to much more intimate contact with the apparatus itself, the refiner becomes familiar with those theories of chemistry and physics which bear upon his daily problems. When these do not seem to harmonize with his experience, he is compelled to do such research work of his own as his facilities permit. However crude his results might appear to the pure scientist, they seldom pass unnoticed by his fellow refiners and are a source of enlightenment to himself.

The question of steam control for distillation and fractionation has always been a very important one in every refinery. The amount and temperature of the steam used in a still, evaporator or tower is usually left to the experience of the still-foreman, and as it is the laboratory that specifies the quality of his products, it seems reasonable that the laboratory should assist the stillman by experimental work on his problems.

The chief benefit derived from steam during distillation is in its property of lowering the average boiling point of the complex mixture in the still or tower. This means that there is a definite temperature and a definite percentage ratio for the steam and oil mixture, at a fixed pressure for each individual operation which will constitute the procedure for maximum efficiency.

The laboratory problem, let us suppose, is to determine the amount of steam that should be used in distilling and fractionating a treated pressure-distillate. The distillate is to be heated in a pipe-still and transferred into the side of a bubble-tower. A light gas-oil is to be "knocked back," and run continuously from the bottom of the tower, while one grade of gasoline is to be taken over-head through the condenser.

The steam-spray is situated in the lower part of the tower, below the transfer entrance, but above the liquid level of the gas-oil bottoms.

Because of the unsaturated condition of the treated pressure-distillate and the delicately balanced molecular structures of its many components, a dry distillation will invariably create chemical reaction, disintegration and polymerization, to such an extent as to defeat the very purpose of treatment and fractionation. This means that the normal boiling-temperatures necessary to the formation of the required

gasoline condensate are too high to produce a pure product from even the most efficient apparatus.

In the instance where insufficient steam is used, it will be noticed that the gasoline produced has an obnoxious odor and will show reversion of color on standing. The average boiling temperature is still too high in this case.

MUST MANIPULATE STEAM

In the case where too much steam is used, the other conditions that regulate the process can usually be adjusted to produce a satisfactory product, but the excess of steam is not reducing the boiling points and is only a heating medium. Besides being a costly procedure, this instance will actually show higher boiling points than are necessary.

When the ingoing steam is excessively superheated, it is invariably of insufficient quantity to produce the maximum amount of temperature reduction. The effect on the resultant gasoline, due to local overheating of the vapors, is that the few harmless sulphur compounds left in the treated pressure-distillate have changed chemically to undesirable compounds which have distilled over.

From the foregoing information it is obvious that we must prdouce the mildest possible conditions in our apparatus, if we desire the purest possible gasoline product. Then, since the amount and temperature of the steam introduced govern the temperature of the incoming oil and the capacity of the apparatus, we must manipulate the steam to produce the minimum distillation temperature.

The temperature of the steam, first of all, should be the same as the temperature of the oil and vapors leaving the pipe-still, to produce the mildest condition in the tower. The amount of steam, at this temperature, that will produce the maximum amount of overhead-end-point-gasoline, may be found by experiment in the laboratory.

The apparatus required for this vapor-pressure experiment is very simple, as is the experimental work itself.

The pressure-vessel, Figure 1, is made from a two-inch iron nipple, threaded on both ends, with a cap on one end and a reducer on the other. A 200-pound pressure gauge is screwed into the reducer, and four short legs or spacers should be provided for the vessel to stand on. The vessel stands in a bucket of oil, so that the oil level comes to the bottom of the gauge, the vessel and gauge-stem being immersed. A thermometer is suspended in the oil bath so that the bulb touches the side of the pressure-vessel, at about the center of its length. A large steel spatula is used as a stirring paddle in the oil-bath, which is heated by means of a Bunsen burner or an electric heater.

VAPOR PRESSURE CONTROLS

In dealing with mixtures of water and pressure-distillate, we knew that a mixture with a low boiling range at a fixed pressure, will have a high vapor-pressure at a fixed temperature. Conversely, a mixture having a higher boiling range, will have a correspondingly lower vapor pressure at the fixed temperature. Since the pressure-distillate is composed

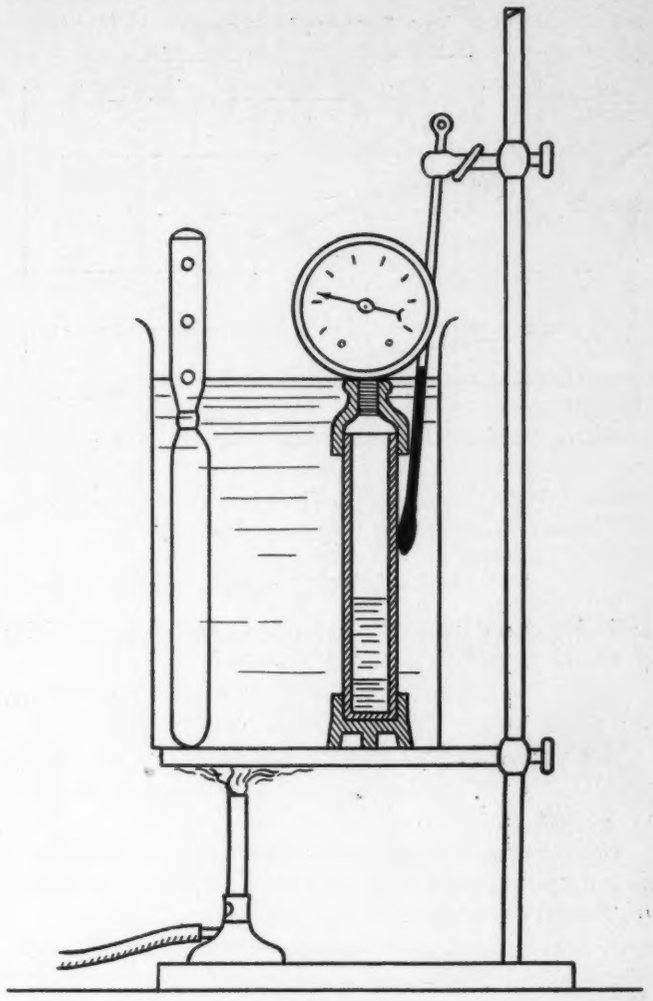


FIGURE 1.

of many differing hydrocarbons, it has no definite boiling-point at a given pressure, but does have a definite vapor-pressure at a given temperature. Therefore, if we can determine the water and distillate mixture that will produce the maximum vapor-pressure, at a fixed temperature, we will then know the quantity of steam to use in the plant apparatus.

To conduct the experiment, the pressure vessel is removed, the pressure gauge removed and 100 ccs. of treated pressure-distillate poured in. The gauge is then replaced to make a tight joint; the vessel is placed in the oil bath, and the burner placed in such a position under the bath, as to be as remote as possible from the pressure vessel. The oil is continuously agitated in the bath, and the temperature raised at a rate of 10 degrees a minute. Since 300 F. would be about the operating temperature of the plant apparatus, the oil bath is brought to this temperature and held constant for 15 minutes, or until the pressure remains steady for five minutes in the pressure vessel.

Let us suppose the gauge shows 80 pounds per square inch, then 80 pounds is the vapor-pressure of the distillate at 300 F. A small correction for the air in the vessel, need not be considered, as it is the same for each determination.

The pressure vessel is now emptied, cooled, charged with 10 ccs. water and 90 ccs. of distillate,

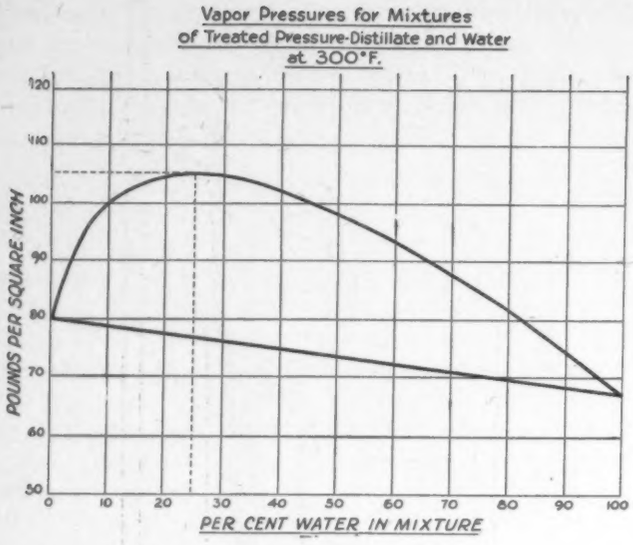


FIGURE 2.

and the same procedure followed as before. The pressure recorded is now 100 pounds.

With a mixture of 20 per cent water by volume, the gauge reads 105 pounds let us suppose.

With three or four more determinations we finally use 100 per cent water and find a recorded pressure of 67 pounds, at 300 F.

From our readings, we next plot a curve, Figure 2. If we had attempted to calculate the vapor-pressure of these mixtures by the formula:

$$P = \frac{mA + (100-m)B.,}{100}$$

we would have obtained values that give the straight line, that is now the chord of the curve. By comparing the straight-line pressures with the curve, the advantages of using steam become graphically clear.

The highest pressure reached by our curve is 106 pounds at 300 F., by a mixture of 24 per cent water by volume, and 76 per cent of treated pressure-distillate. This particular curve applies only to this particular treated pressure-distillate, and is intended only as a guide for further experimental work. The general procedure, however, may be followed for any problem where steam is used in distillation, and of course the working temperature must be selected to suit the case in point; 300 F. only being advisable in this particular case.

We have now gained the information that such an amount of steam must be used in the tower of the apparatus as to give the ratio of 76 volumes of treated pressure-distillate charged, to 24 volumes of condensed steam.

TELL TALE METHOD

An orifice meter might be used to regulate the volume of steam going to the tower, but a more satisfactory regulation is accomplished by the tell-tale method. This tell-tale is a half-inch line, let into the overhead vapor line at a point where it will withdraw an average sample of the vapors as they leave the still head. The line then has a downward flow to a point in the receiver house, by the shortest route. For about 20 feet of its length, the tell-tale line lies inside a pipe of larger diameter, and this larger line acts as a condenser, with water filling the annualr space and overflowing into the condensor box. The open end of the tell-tale in the receiver house is fitted with a valve for sampling, and a branch line, teed in above the valve, leads into a convenient look-box. This branch keeps the tell-tale line drained, when not in use, or when the sample valve is closed.

In order to explain the value of tell-tale samples in regulating the steam and treated pressure-distillate ratio, let us suppose our still to be in operation.

We are charging 1500 gallons an hour of treated pressure-distillate through a meter and exchangers to the furnace tubes.

The transfer temperature, entering the side of the tower is 325 F., and we are introducing steam at a certain temperature and pressure. We are running gasoline into the run-down tank, at the customary gravity, to give the desired end-point product, and the run-down tank gauge shows us to b making 70 per cent gasoline from the charging stock.

Under these conditions, if the tell-tale sample shows a mixture of 40 per cent water and 60 per cent gasoline by volume, then the tower ratio will be 40 parts of water to

$$\frac{60 \times 100}{70}$$

parts of treated pressure-distillate. The amount of steam then is 32 per cent of the mixture in the lower part of the tower, while the amount of treated pressure-distillate is 68 per cent by volume.

If we now cut the quantity of steam down to the point of maximum efficiency, which we found to be 24 per cent, by sampling the tell-tale from time to time, we will find that the overhead product, or gasoline, has become heavier in gravity and higher in end-point. This condition is corrected by lowering the furnace temperature, and consequently the transfer temperature, until the gravity has returned to normal. The transfer has now dropped to 300 F., let us suppose; then we must adjust the temperature of the steam introduced to 300 F. This may be done by a judicious mixture of live steam with exhaust staem, by the addition of water to the live steam, or by the superheating of exhaust steam.

We may now be satisfied that the apparatus is running efficiently and that the gasoline product is vaporizing under the mildest condition in the fractionating column.

A high vacuum is sometimes employed in the distillation processes where a very low gravity condensate is desired, and is the best means for reducing boiling points; but cannot be used where light distillates are to be fractionated, for the reason that a vacuum will defeat the purpose of the fractionating tower.

In cases where lubricating oils and cylinder-stocks are being reduced to viscosity and flash-point, a high vacuum with a little steam for agitation, will prove most satisfactory.

The Chemistry of Cracking Petroleum

By ISMAR GINSBERG

CRACKING of petroleum products is an operation which can generally be considered as being composed of two essential parts or stages. In the first stage of the operation the original oil is broken down into products of lower specific gravity and lower boiling point, and in the second stage of the process condensation products are formed. From the purely practical standpoint it may be held that the reactions that take place in the first stage of the cracking process are more important than those that ensue in the second stage. Nevertheless, from a chemical standpoint both stages of the cracking process are of equal importance. It is, furthermore, wrong to hold that the second stage of the cracking process is devoid of practical importance. It must be remembered that the commercial value of a cracking process is dependent to a large degree on the progress of the coke-forming process, and the formation of coke cannot be considered to be anything else than the final stage of the condensation process.

Many investigations have been made on the technology of oil cracking and also on the chemistry of the process. A very interesting research was recently reported in Erdoel and Teer, 1928, page 9 ff. This research was carried in Russia by J. N. Sachanow and M. D. Tilitschew. The purpose was to try to explain the relationship in the condensation process between the duration of the cracking and the density of the cracked oil, that is of the portion boiling above 300 C., when both the temperature and the pressure remained constant.

The oil used was a paraffin-rich distillate obtained from Russian sources with a specific gravity of 0.883. The experiments were carried out at a pressure of 10 atmospheres and at a temperature of 425 C. The duration of cracking was varied from 34 minutes to 94 minutes. The results indicated that the specific gravity of the fraction boiling over 300 d. C. showed a constant tendency to increase as the duration of the cracking itself increased. It, therefore, appears that the duration of the cracking process may be told from the specific gravity of this fraction. This fact can be used in practical work to control the cracking process. Thus for example if the specific gravity of the cracked oil fraction reaches a definite limit, which is located just before the coke-forming point, then the operator knows that it is time for him to add fresh oil to the still, replacing the residuals that are still contained in it.

There is one part of the cracking process that has not received much attention from the chemical standpoint, and that is the formation of high molecular weight hydrocarbons from simpler molecules. It is, of course, known that aromatic hydrocarbons are wont to polymerize or condense by splitting off hydrogen. Thus two molecules of benzol will condense to form one molecule of $C_6H_5.C_6H_5$, one molecule of hydrogen being split off. When the heating is continued and the polymerization is allowed to go on indefinitely, coke, that is pure carbon, is finally formed. The conclusion has been drawn that the formation of condensation products during the cracking of oils takes place for the most part at the expense of the aromatic hydrocarbons.

COKE NOT FROM CONDENSATION

Experiments were carried out to determine the correctness of this assumption. Tests were made at a temperature of 450 C. and a pressure of 10 atmospheres, these conditions being maintained constantly. The substance used was ordinary paraffin. The duration of the cracking was varied from 12 to 32 hours and the specific gravity of the fraction boiling above 300 C. was determined. The quantity of condensation products in per cent. of the original material was also determined. The results clearly indicated that there is but little tendency for condensation on the part of paraffin hydrocarbons. This also means that the formation of coke during the cracking process cannot be assigned to the condensation of these hydrocarbons.

Tests were also made with the same paraffin-rich petroleum, mentioned above, which, however, was first refined with the aid of eighty per cent. by volume sulphuric acid. It was assumed that when the oil, which was preliminarily refined with sulphuric acid, is cracked, there is practically no possibility of the formation of coke, for the reason that the acid treatment removes the aromatic hydrocarbons. The experiments were carried out at a temperature of 450 C., a pressure of 10 atmospheres and the duration of the cracking was 36 minutes.

The results indicated that the removal of the aromatic hydrocarbons by the refining of the oil with sulphuric acid had a marked effect in reducing to a minimum the tendency of the hydrocarbons to polymerize and form condensation products. Thus the percentage content of carboids in the unrefined oil was 3.47 per cent. while that in the refined oil only 0.11 after cracking had taken place. It may, therefore, be concluded that the formation of condensation product during the cracking of oil, and hence the deposition of carbon within the cracking retort and the like are due to the aromatic hydrocarbons contained in the oil which are subjected to polymerization during the cracking process.

MANNER OF CRACKING DETERMINED

It was also thought advisable to carry out an investigation to determine the manner in which the individual

hydrocarbons, contained in the petroleum, that is the paraffines, naphthenes and aromatic hydrocarbons are cracked. This is of course a purely chemical proposition and more or less of theoretical interest. The reader who is particularly interested in it will find much information in the original article mentioned above as well as references to other articles on the subject. Suffice it to say that the splitting of the paraffin hydrocarbons appears to result in the formation of olefines in addition to lower members of the paraffin series. The naphthenes react during cracking along two different directions. In the first place the side chain is broken down and in the second place hydrogen is evolved and aromatic hydrocarbons are formed. As far as the aromatic hydrocarbons are concerned, there are two characteristic reactions. In the first place condensation products are formed and in the second place the side chains are broken down.

The methods that are used to determine the composition of the cracked gasoline are also described. The reader who is interested is referred to the original article.

A very thorough investigation was made of the gasoline and illuminating oil that were obtained by the cracking of paraffin. These products appear to be made up entirely of paraffins and olefines and both naphthenes and aromatic hydrocarbons are absent or nearly so. The determination of the physical constants of these products, that is the fraction boiling up to 200 C. and the one boiling between 200 and 300 C., yields information of considerable value and interest.

The cracked products obtained from paraffin were distilled in a still provided with a dephlegmator and fractions of 20 degrees C. range were obtained. Each of the fractions was treated with 80 per cent. concentrated sulphuric acid and under these conditions the reduction in volume was observed to be very small indeed. After neutralization and drying each individual fraction was again fractionated in the still provided with a dephlegmator. A certain portion of the fraction distills over within the former range of temperatures, and then the temperature quickly increased and thereat the olefinic polymerization products began to come over. The distillation was interrupted at this moment and the weight of the residual oil was determined. The found weight was then added to the quantity of oil absorbed by the sulphuric acid. The sum indicates the total content of olefines in per cent. in the considered fractions.

The following tabulation shows the physical constants of individual fractions as well as the iodine numbers and the olefine content.

Boiling Range, degrees C.	Specific gravity	Coefficient of Refraction	Iodine No.	Olefine content determined with 80% Sulphuric Acid
40 to 60	0.652	1.3702/30 deg.	..	45.3
60 to 80	0.680	1.3819/31 deg.	169.3	33.8
80 to 100	0.706	1.3942/31 deg.	148.6	15.0
100 to 120	0.725	1.4035/31 deg.	135.3	11.9
120 to 140	0.736	1.4105/31 deg.	125.9	8.0
140 to 160	0.748	1.4175/29 deg.	113.1	6.5
160 to 180	0.759	1.4227/29 deg.	103.3	4.6
180 to 200	0.767	1.4268/29 deg.	89.2	4.2
200 to 220	0.776	1.4309/30 deg.	74.2	3.8
220 to 240	0.782	1.4341/30 deg.	63.5	3.2
240 to 260	0.790	1.4382/30 deg.	54.0	2.3
260 to 280	0.797	1.4420/30 deg.	44.2	..
280 to 300	0.804	1.4450/30 deg.	37.3	..

If it is taken into consideration that the average molecular weight of the fractions under investigation increase with increasing boiling temperatures, then the changes in the olefine content of the individual fractions, which are expressed by the iodine coefficient, must be considered as unimportant. On the other hand the values that are obtained with 80 per cent. sulphuric acid show a marked tendency to decrease which indicates that the removal of the olefines with the aid of sulphuric acid is by no means complete. This then means that the determination of olefines by means of sulphuric acid will give somewhat too low values and correspondingly the results obtained for aromatic hydrocarbons will be too small.

NO POLYMERIZATION

Tests were made to determine the physical constants of two fractions, obtained first from the start of heating up to a temperature of 200 C., and second from 200 degrees C to 300 C. Fuming sulphuric acid was used in the tests. An aniline number of 70.8 degrees was found for the gasoline fraction, and this corroborated the contention that the product obtained by the cracking of paraffin consists only of paraffin, that is saturated, hydrocarbons. This then led to the simultaneous conclusion that no polymerization of the olefines to naphthenes took place during the cracking process.

The cracked gasolines obtained from the aforementioned paraffin-rich distillates under different experimental conditions were examined in the unrefined state. It was determined very definitely that the olefine content of the gasoline decreases with the pressure. The aniline point of the fractions up to 200 C. indicates that there is only a very slight amount of naphthene hydrocarbons in the gasolines. Tests were also made to determine the constants of gasolines which were obtained from the same paraffin-rich distillates with variation in the temperature of cracking and in the time of cracking, from which gasolines the olefines and the aromatic hydrocarbons were first removed. The slight difference in the aniline point as well as in the coefficient of refraction of light indicate that the naphthene content has remained about the same in all cases.

When crude oils of different origin are cracked under like operating conditions, then it is found that there is a definite relationship between the properties of the original crude oil and those of the cracked products obtained from it. Thus heavy paraffin-free crude oils yield heavy cracked products containing a high percentage of cyclic hydrocarbons. On the other hand lighter cracked gasolines or cracked light oils are obtained from the paraffin-containing crude oils and these cracked products contain a high percentage of saturated hydrocarbons. In all the tests carried out in this investigation the percentage of naphthenes in the cracked products varied between four and seven per cent., but even within this narrow range it was possible to distinguish between crude oils of various properties. Thus the percentage of naphthenes in cracked products obtained

from crude oils, which contain no paraffin hydrocarbons, was considerably more than in the cracked products obtained from paraffin-rich crude oils. When the crude oil containing paraffin hydrocarbons was first purified by treatment with an excess of fuming sulphuric acid, then the cracked products contained no naphthenes at all. The conclusion drawn from these observations was that the naphthene hydrocarbons which are contained in the cracked products, must originate from the preliminarily formed higher molecular weight naphthenes in the crude oil and that the olefine hydrocarbons have scarcely any action at all in the new formation of naphthene molecules.

Tests were also made on straight-run gasoline before and after treatment of the product with sulphuric acid. The percentage of aromatic hydrocarbons, naphthenes and saturated hydrocarbons, was first determined by absorption with 98 per cent. sulphuric acid. The naphthene content was then calculated from the aniline point after the aromatic hydrocarbons had been removed. The percentage of saturated hydrocarbons was then determined by difference. The results showed that the naphthene content of the straight-run gasolines, varying from 21.7 to 33.9 per cent., that is from 20 to 30 per cent. greater than in the case of the cracked gasolines, was the main point of difference between the two.

It is, of course, understandable that the chemical composition of a gasoline has an important bearing on its behavior in the internal combustion engine. The presence of aromatic hydrocarbons, naphthenes and olefines has a favorable effect on the anti-knock properties of the motor fuel, but this effect is altogether different according to the nature of the hydrocarbons. It is necessary that the fractional analysis of the motor fuel is properly understood with respect to the composition of the gasoline, for the two together must be used in evaluating a gasoline.

The presence of naphthenes and olefines in the motor fuel has an important action on the anti-knock properties of the fuel. It has been estimated that in a gasoline, which contains principally saturated hydrocarbons, four per cent. of naphthenes or five per cent of olefines have the same effect approximately as one per cent. of toluene. The cracked gasolines that were obtained in these experiments are much superior to the straight run gasolines, as far as anti-knock properties are concerned, this being due to the fact that the cracked gasolines contain considerably greater proportions of aromatic hydrocarbons than the ordinary gasolines.

It has been stated that chemical composition of the cracked gasolines is of considerable importance in establishing the value of these products and their behavior in the gasoline engine. However, as all oil chemists know, the analysis of a petroleum distillate is ordinarily a very difficult task and this is particularly true of quantitative analysis. For this reason the total quantity of aromatic hydrocarbons and olefines were alone determined. The method used consists simply in treating the cracked product with fuming sulphuric acid. A certain amount of acid tar separates out after the mixture of distillate and acid is allowed to stand over night and the volume increase of the tar is determined. The residual oil is then separated from the tar, neutralized, washed and redistilled. The properties of the original gasoline distillate were determined as well as those of the refined distillate (between 200 and 300 C.).

EFFECT OF ACID

The content of olefines and aromatic hydrocarbons in the distillate varies between 26 and 33 per cent. It was found that the refining of the distillate with the aid of fuming sulphuric acid gave products which did not vary so much from one another in physical properties, such as specific gravity and coefficient of light refraction. This is an important point in the manufacture of cracked gasolines.

The final results that were obtained in this series of experiments on cracked gasoline and the determination of the relation between the properties of the refined and unrefined gasolines with one another and with gasolines from crude oils that contain considerable proportions of paraffin hydrocarbons and those that do not are contained in the following tabulation.

Fraction 200 to 300 degrees C—	Sp. gr. 15° C	Coefficient of refraction at 15° C	Aniline point
From crude oil, rich in paraffins.			
Unrefined	0.814	1.4552	70.8°
Refined with 100 vol.% fuming sulphuric acid	0.796	1.4430	82.0°
From crude oil, free from paraffins.			
Unrefined	0.841	1.4696	60.2°
Refined with 100 vol.% fuming sulphuric acid	0.818	1.4516	77.3°

The following conclusions have been obtained from these experiments. Some of these conclusions are of theoretical importance only while others are also of considerable practical importance.

A paraffin-rich crude oil was cracked and gave 30 to 35 per cent. of gasoline and approximately as much kerosene. When the amount of cracked gasoline was limited to 30 per cent., then the residue in the still was suitable for use as a fuel oil. The cracked gasolines were highly stable products. The speed of decomposition increases as a general rule with the rising specific gravity of the fraction. Thus lubricating oil distillates that had approximately the same specific gravity as the paraffin-rich distillates were decomposed just as quickly as the latter. On the other hand lighter distillates such as solar oil or illuminating oil were decomposed much more slowly.

It was determined that as a general rule an increase in the temperature of 10 degrees Centrigrade was equivalent to doubling the speed of cracking. The effect of the temperature on the formation of coke was entirely similar. Nevertheless the properties of the crude oil are highly important in this connection. When a definite maximum pressure within the cracking still is overstepped, then the yield of cracked gasoline will be reduced. As the pressure increases the olefine content of the cracked gasoline decreases. The formation of naphthenes from olefines during the cracking process, a phenomenon which has been mentioned by various investigators, is not corroborated. No coke is formed during the cracking of paraffin hydrocarbons.

Pure Oil Company Making Further Installations Of Gyro Cracking Process

By GEORGE REID
Associate Editor

AFTER successful operation of its Gyro vapor phase cracking unit at the Cabin Creek, West Virginia, refinery, the Pure Oil Company is placing two more of these units in service at the Smith's Bluff, Texas, and Heath, Ohio, plants. The first unit at Cabin Creek was announced, as to its operation and methods of processing, in the fall of 1927. Installations recently completed essentially follow the design of the original installation, so far as principle is concerned, but with some minor changes in design, which have been influenced by the type or quantity of charging stock.

It is planned to install complete units at Pure Oil Company's other refineries, as Marcus Hook, Pennsylvania, and Muskogee, Oklahoma. Two units of the Gyro process are in operation in Canada at the refineries of the McColl-Frontenac Company.

According to the technical staff of the Pure Oil Company, the final development of the Gyro process comes after 12 years of exhaustive research work and experimentation. The perfected process has many interesting features, which will be described later. It is a cracking process, but unlike the familiar extensively employed high pressure units, the Gyro operates at atmospheric pressure, cracking in the vapor phase. The elimination of high pressure reduces heavy maintenance costs.

NO COKE FORMED

Another feature of interest is the fact that no coke is produced in the operation of this vapor phase system, and since in liquid phase cracking the time on stream is dependant upon the time required to fill a reaction chamber with coke, the elimination of coke deposition permits practically continuous operation. Further, fuel costs are comparable, and virtually on a level with, like costs in the operation of the high pressure unit. The excessive formation of fixed gases, which has been one of the chief problems in vapor phase cracking, has been overcome, and the fixed gas figure reduced to 25 per cent. in the operation of the Cabin Creek unit. A typical yield of this operation, charging gas oil to the unit is reported as follows,—gasoline, 60 per cent.; fuel oil 15 per cent and fixed gas, 25 per cent.

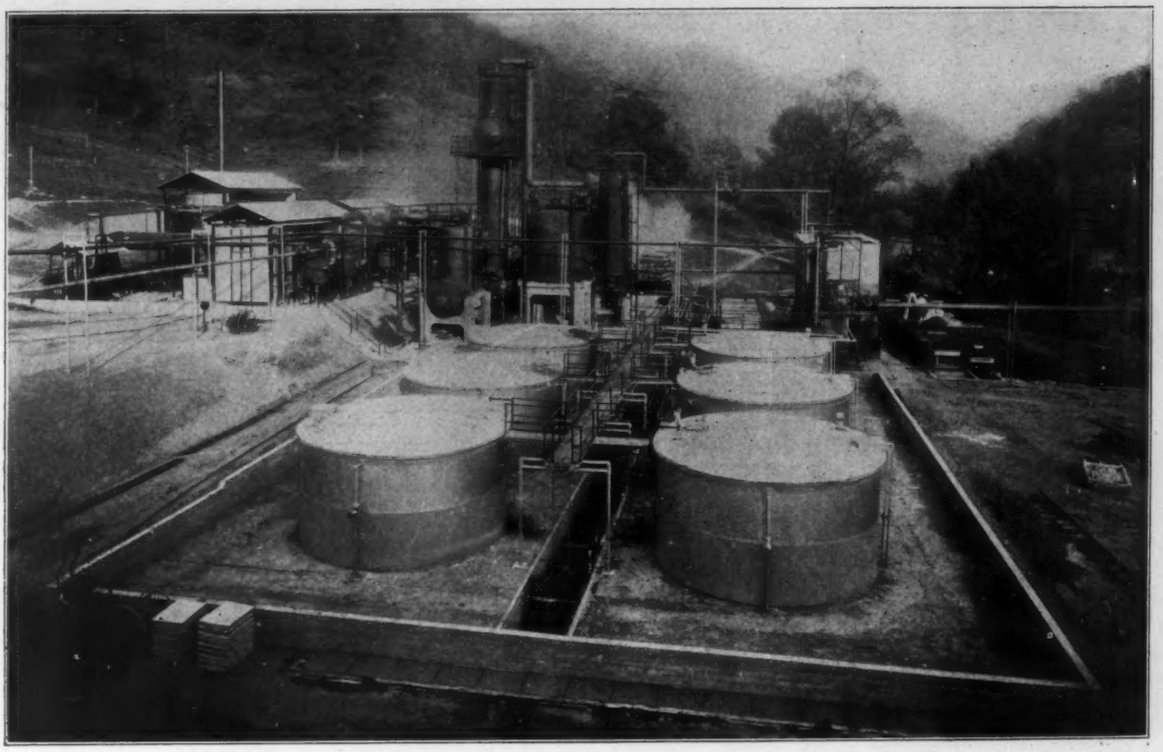
The fixed gases are compressed for removal of the gasoline content. The fuel oil is free of suspended matter, asphaltic or carbon, and is produced with a low cold test and a low viscosity.

At the time of the writer's visit to the Heath, Ohio, plant, the Gyro unit there was not yet completed. This unit charges crude oil direct, and skims and cracks in the same pass through. No flow chart was available showing the details of construction, hook-up and operation of either this new unit, nor the one at Smith's Bluff, and for this reason the original Gyro unit at Cabin Creek is discussed in detail, and the flow sheet illustrating design and system of operation is employed for purposes of illustration.

R. C. Osterstrom, chief chemist for the Pure Oil Company, has made the following analysis and description of the type of equipment employed in the process, and the methods of operating the Cabin Creek unit.

"Refering to the flow diagram: The fresh oil is taken from tank A by pump B and sprayed into tar leg C. The fresh charging stock introduced at this point is used as the medium for shock-chilling the vapors entering tar leg C, from the converter, and the fresh charging stock incidentally, is preheated before being pro-

General view of Pure Oil Company's first Gyro vapor phase cracking unit, in operation at the company's Cabin Creek, West Virginia, refinery.



Close up of Pure Oil Company's Gyro units which has been in operation since the fall of 1927 at Cabin Creek, West Virginia

cessed. Any oil which can be vaporized is suitable for charging stock to the Gyro unit. At Cabin Creek, gas oil, foots oil, and petrolatum from Cabin Creek crude, are used. The liquid from the tar leg (that part not vaporized) flows by gravity into a reservoir in the bottom of the fractionating tower D. The material to be processed is then pumped by means of a hot oil pump, O, and passed through the tube still E, where it is brought to a temperature sufficient to vaporize the portions it is desired to process.

"From the tube still the oil is charged into evaporator F, the unvaporized portions dropping out in this evaporator and being removed as fuel oil. In the evaporator, approximately three per cent. by weight of steam is introduced. The steam and oil vapors pass from this point through a separator G where any large amounts of entrained liquids are removed and drained back to the bottom of the fractionating tower, D. After leaving separator G, the vapors pass through "converter" unit, P, and at this point are brought to conversion temperature of approximately 1100 F.

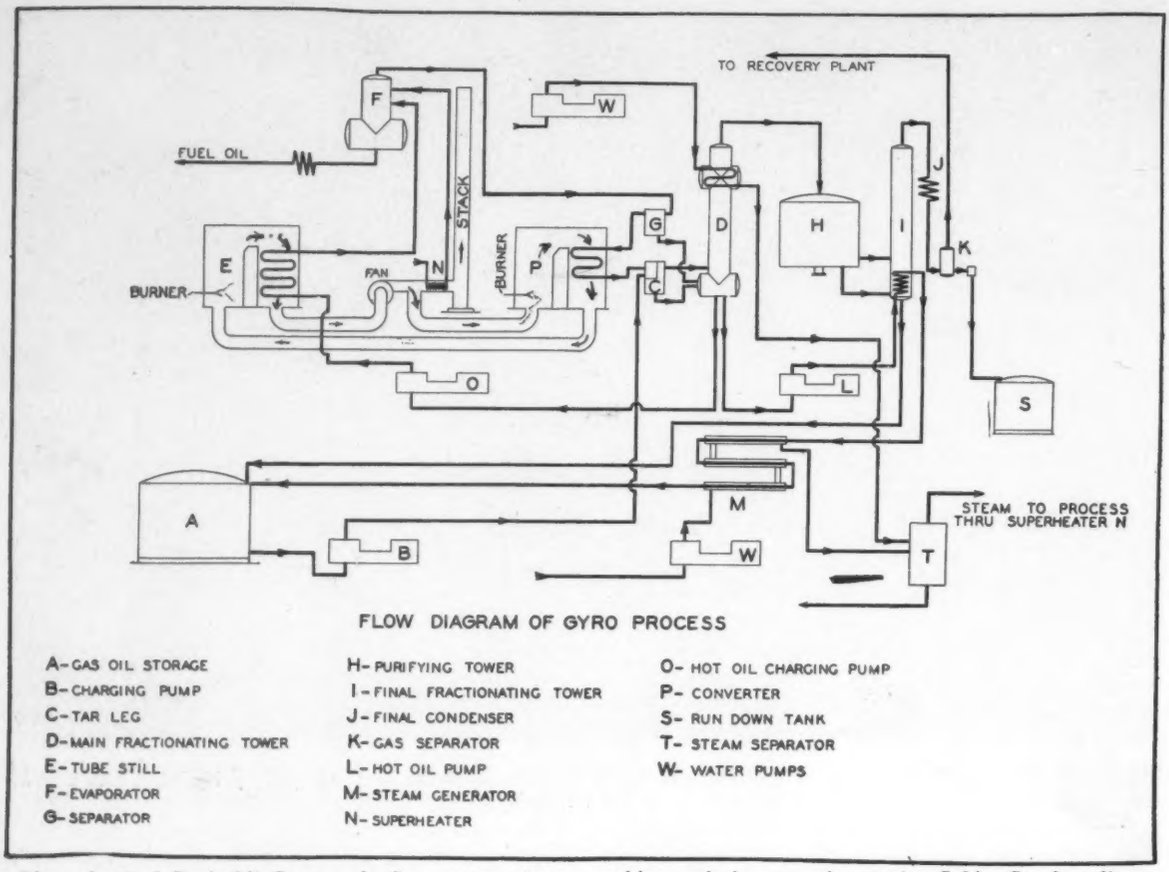
CATALYTIC FEATURE

"A novel feature should be mentioned in the convertors,—the use of a catalyst in the tubes. This catalyst consists of a cylindrical core of concrete impregnated with iron oxide; the iron oxide being the catalyst, and the concrete being merely the carrying medium. The core is supported in the center of the tubes to eliminate the possibility of developing hot spots, to assist in producing high vapor velocities through the tubes.

"Steam dissociation makes available hydrogen and oxygen, and the hydrogen in the presence of the catalyst at these temperatures, combining with unsaturated hydrocarbons to form new compounds. In the event that charging stock from crudes are used which contain high percentages of sulphur, the iron oxide might be changed to iron sulphide, but the free oxygen obtained in the dissociation of the steam would replace the sulphur and prevent 'poisoning' of the catalyst. As a result, therefore, it has been found necessary to replace these cores only when they begin to disintegrate; the replacement being approximately 10 per cent. per year.

"The vapors pass from converter P, into tar leg C, where, as stated above, fresh charging stock is introduced for chilling the vapors and preheating the fresh charging stock. The uncondensed vapors pass from the tar leg C into the fractionating tower D where the material that was not converted is dropped out to the bottom of the tower, and the desired vapors having the boiling point of the finished product pass overhead and may be led through purifying tower H. This purifying tower, if desired, may be of the design commonly used for vapor phase filtering, wherein fuller's earth or similar material is utilized. The treated vapors pass from purifying tower H to a second fractionating tower I, where final separation of the undesirable hydrocarbons is accomplished and the desired products pass overhead through the final condenser J to gas separator K. In gas separator K the finished Gyro is separated from the fixed gases produced in the converter operation. Of course, the fixed gases eventually pass through a compression gasoline recovery system, so that the gas leaving the system is practically free of stable gasoline, and can be used as fuel.

"In order to maintain proper temperature in the tar leg it is necessary to introduce charging stock in excess of heat required for the process. To prevent accumulation of charging stock in the reservoir in the base of the fractionating tower D, a second hot oil pump L removes the excess, pumping it through a coil in tower I where the hot oil is used as an aid for fractionating in tower I. After passing through this coil the excess hot



Flow sheet of Pure Oil Company's Gyro vapor phase cracking unit in operation at its Cabin Creek refinery.

charging stock goes through a double pipe heat exchanger M, and the heat utilized for the generation of steam that is used in the process. After passing through this heat exchanger, the oil passes through a final cooling coil and back to storage A. The outlet temperature of tower D is maintained constant by means of an automatic control steam boiler which also generates steam for the process. The steam may be superheated by passing it through superheater coil N installed between the pipe still and the stack.

FUEL SYSTEM

"Another novel feature is the fuel system put into effect in this installation. The principal combustion of the fuel takes place in the converter P. The temperatures reached in this combustion chamber are approximately 3000 F. At the top of the combustion chamber and before making contact with the tubes, these gases at this temperature are diluted with gases of about 500 F. Therefore the temperature of the diluted gases that actually make contact with the tubes is approximately 2000 F. The flue gases leaving the converter at around 1400 F. are drawn into the combustion chamber of the tube still E and across the tube heating furnace. Tube still E is provided with a combustion chamber to make it possible to make up any heat deficiency that might exist when the gas is brought from converter P. The flue gases leaving the tube still E at approximately 500 F. are conducted through ducts by means of a circulating fan and circulated back to the converter P for dilution as mentioned above. Any excess gas handled by the fan is discharged across the steam superheater N and thence up the stack. Every precaution has been taken to prevent leakage of air into any part of the settings or ducts. Also, the converter combustion chamber is operated with practically no excess air. Naturally, these precautions make for longer life of the tubes, in preventing oxidation.

"The gas oil from the Cabin Creek crude, when this material is being used for charging stock has approximately the following tests:

Gravity	39.9	Vis at 100	42
Flash	190	Pour	20
Fire	240	Gasoline in stock	1%

The gasoline made has tests approximately as follows:

Color	16/18	70%	320
Gravity	58.3	80%	348
Initial	98°F.	90%	382
10%	150	95%	405
20%	178	Iodine Number	205.5
30%	204	Naphthenes	15.1
40%	230	Olefines	50.0
50%	258	Paraffines	00.0
60%	290	Aromatics	34.9

These tests as given above, indicate much of the unusual properties of the motor fuel derived from the operation of the Gyro unit. It is said that a mixture of this product with 50 per cent. of straight run gasoline, gives a motor fuel with virtually the same antiknock values of a 50 per cent. benzol blend.

The fixed gases derived from the Gyro unit normally has a Bt.u. value of 1800 per cubic foot, and contains approximately 55 per cent. of unsaturated hydrocarbons, thus providing an excellent raw material for various types of chemical syntheses.

The fuel oil produced by operation of the unit, has a low gravity, it is low in viscosity, has a zero cold test, and is not contaminated by solid material in suspension that might give rise to the usual problems in consumption of cracking unit residuums.

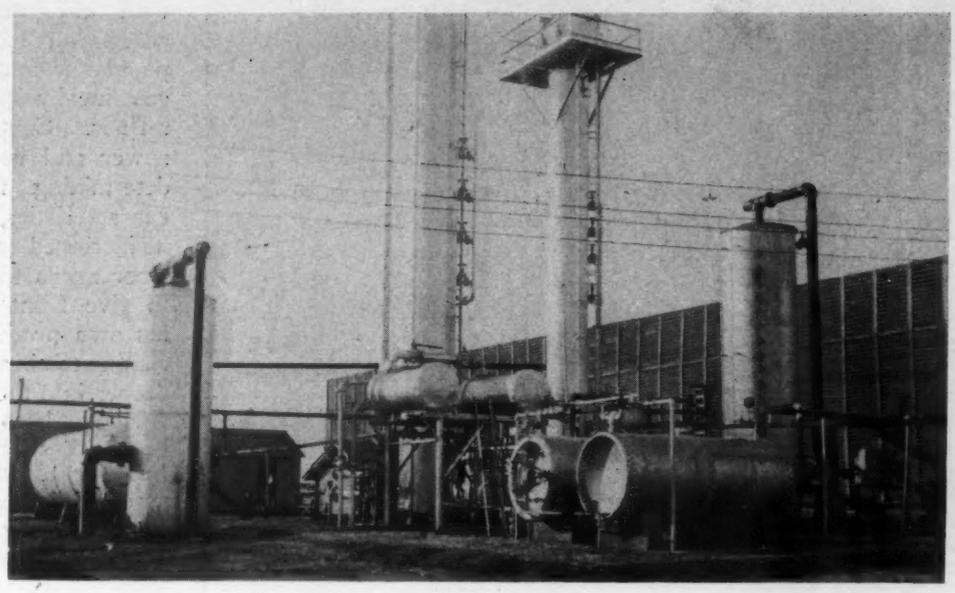


FIGURE 1
Two column high pressure fractionating installation for the preparation of "Skelgas"

Fractination and Its Practical Results

By EMBY KAYE
Skelly Oil Company

AFTER all is said and done, inventions and improvements in an industry are important only in relation to their effect upon the balance sheet of a ledger. Since 1923 a great literature has sprung up on fractionation in the refining and natural gasoline branches of the oil industry. While primarily used for rectifying unstable natural gasoline, fractionation is more and more being employed in the refinery. Cracking, particularly in the vapor phase, and the improved efficiency of vapor recovery plants, have so increased the amount of lighter fractions and fixed gases in refinery gasolines that vapor tension or vapor pressure may become a specification for motor fuels. Fractionation will be the means of controlling vapor pressure. The practical benefits of this fractionation are not dissimilar from those experienced in the natural gasoline industry.

Not only in the early development, but up to seven years ago, natural gasoline was a product of no given specifications, and while specifications were adopted at that time, it was not until two years later that specifications were controlled within reasonable limits. The material sold was nothing but what the plant happened to make. The only control exercised in the pre-stabilizer days was blending and weathering, and even such control exercised chiefly to meet transportation regulations promulgated by the Bureau of Explosives.

In the past few years, considerable research work has been done, that received its impetus from overproduction and a resultant declining market. The manufacturer engaged the scientist to examine and diagnose his product and advise whether it was a useful product and whether it might be manufactured and marketed at a profit. If the so-called gasoline was deficient, the scientist was to advise whether or not it might be improved, and, if so, how that was to be accomplished.

VOLATILITY CONTROL

What were the results of this investigation? First of all, it brought about the development of methods and equipment for gas and gasoline analysis. By means of this new art the percentage composition of the condensed gasoline, in terms of the hydrocarbon components, is susceptible of ascertainment. Through these results the usefulness and performance of gasolines of different chemical composition, can be traced. And, finally, a tool was placed into the hands of the investigator to enable him to design a means of controlling the product in the manufacturing process, to the end that no undesirable hydrocarbons find their way into the finished product.

The first answer to uncontrolled volatility (and that sums up the complaints against natural gasoline up to 1923) was the low pressure rectifying column. The Rafferty & Thompson apparatus threw down the gauntlet to the industry, and as a result, nearly every active manufacturer has had experience with, or developed, some kind of a stabilizing machine. With the advent of by-products and special solvents, a number of manufacturers have installed high pressure rectification towers. In some cases, even where no by-products were desired, a high pressure column was installed at a higher first cost, in order to be able later to add a second, and possibly a third tower, in the event a profitable market was developed for any of the by-products that could be manufactured at that particular plant.

It is erroneous to assume that a stabilizer increases

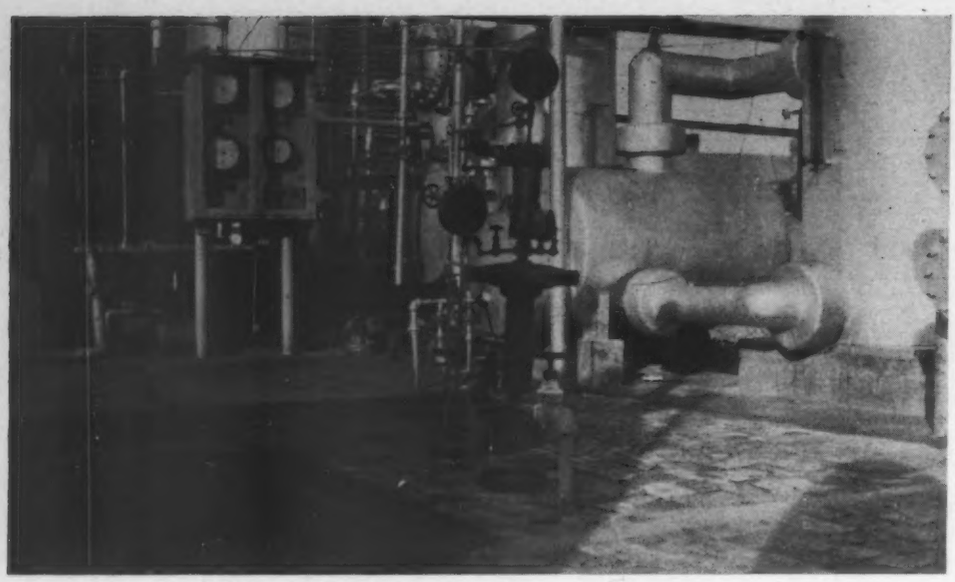


FIGURE 2 *Controls and recording instruments used for regulation of processing in a high pressure fractionating plant.*

plant production per se. But unless the plant happens to be over-size and vapors driven off can be re-processed over and over again, the stabilizer makes possible an increase in volume of gasoline sold, and otherwise adds economies. Indirectly, the stabilizer makes possible the following:

1. Separation of fixed gases from salable gasoline. This cuts down loading losses and reduces outage in transit.
2. Control of the product. Various grades may be made by the elimination or retention of desired percentages of butane.
3. Oil circulation may be decreased in an oil absorption plant. Uncondensed vapors need no longer be recycled through the plant.
4. Lowering the saturation and vapor pressure of the lean oil.
5. Economy of fuel for distillation. Obviously, a reduced oil circulation means less heat exchange, cooling, and preheating equipment, as well as less steam.
6. Liquefication of propane and butane (in the high pressure tower) for by-product purposes.

Given the proper stabilizer, it is important that operating conditions be religiously observed. The machine should be automatic as far as possible; but, like all automatic equipment, must be checked often. From actual analysis, simple plant tests may be worked out for the use of the operator, while a complete analysis should be made from time to time by the control chemist.

Figure 1 shows a two-column high pressure installation. Figure 2 shows most of the controls and recording instruments. Figure 3 shows a bottled gas rack and bottling room.

OTHER ADVANTAGES

Successful fractionation has not only reduced loss through uncontrolled evaporation of good gasoline fractions along with the undesirable fixed gases, but has increased the popularity and use of natural gasoline by its chief user, the refiner. Controlled volatility, newer and better methods of determining natural gasoline characteristics, has resulted in its increased use because the refiner needs the light fractions to give front-end volatility to his own product which is becoming too heavy due to cutting deeper into the crude. The refiner has become satisfied that he can now buy a natural gasoline for blending purposes to give his product added volatility without being afraid that the presence of some of the light fractions will cause vapor-lock in the motor, or gassing in service station pumps, troubles experienced on a large scale at the beginning of the last decade. The stabilizer alone made possible the development in the last two years of an aviation fuel from natural gasoline alone, which is the equal of the highest standard products, with the added advantage of weighing less than refinery fuels within like specifications.

In addition to this high pressure, fractionation is making possible the saving of large volumes of butane and propane for the enrichment of artificial gas and for bottled fuel. Pentane and other cuts are to some extent being taken out and sold as solvents in certain industries where they command a fair price.

Taken all in all, when considered from a purely dollar and cents standpoint, no half-dozen improvements in the natural gasoline business in the last five years—and there have been valuable developments—have meant as much to the gasoline manufacturer as rectification. The whole story has not yet been written. Rectification is yet new. It is now being subjected to a frontal attack by the technicians. It is fraught with possibilities which only the years will reveal.

FIGURE 3 *Bottled gas rack and bottling room where Skelgas is packaged*

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Making Workmen's Meetings a Real Force in Accident Prevention

By C. W. PRICE

Director, Training Course for Safety Engineers, New York University

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THE chief safety engineer of an organization employing more than a hundred thousand men and women in several hundred plants representing a dozen of the major industries of America (the United States Steel Corporation), was asked recently what specific activities had been most productive of results in the plants in which they had reduced accidents 84 per cent. His first answer was: "the departmental monthly meetings of employes" and next "the shorter meetings of workmen called by foremen." The departmental safety meeting of employes has long been helpful in many other companies; regular safety meetings called by and presided over by the foreman are not so commonly recognized as a force for accident prevention.

At such meetings the foreman reviews two or three accidents which have happened during the month and points out what might have been done to prevent them. He then opens the meetings for wholly informal questions, suggestions and general discussion. In many plants of the corporation previously mentioned, the workmen did most of the talking because the foreman had won the confidence of his men and had made the meeting friendly and informal. These meetings are not occasions for oratory, and do not call for any remarkable ability on the part of the foreman. They are simply a little "get-together" for the men of the department to discuss ways and means to protect human life.

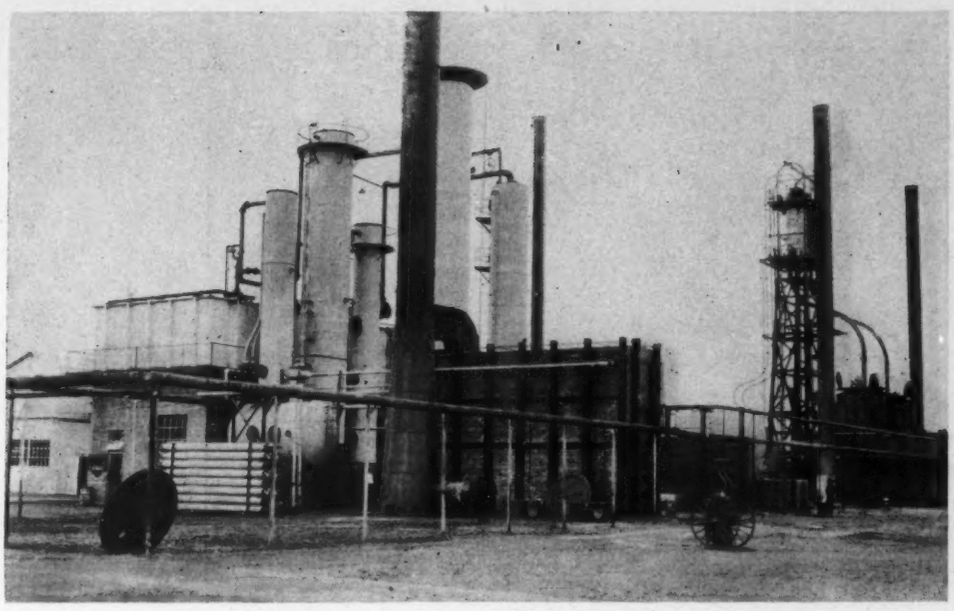
In my work in the last two years I have organized permanent safety programs in a number of large department stores and manufacturing plants. I found one of the most effective methods of quickly lining up a department in which the accidents were increasing was to call all of the employes together for a 10-minute talk, and at this meeting to present the facts in regard to the accident experience and to point out what they can do themselves to protect themselves and their fellow workmen. For instance: we found in one department many serious accidents resulted from women falling in and out of passenger elevators. We started a series of early morning meetings with the 40 elevator operators and in three months practically eliminated all elevator accidents of any consequence. I found that in any department where the record was not satisfactory that I could do more in 15 minutes by calling the employes together than I could possibly do in any other way. At the present time I am working with a large number of automobile fleets and one of the important features of our program is the series of 10-minute meetings of drivers, monthly in some companies, and weekly where conditions are especially serious.

In departmental meetings of employes we are utilizing the same psychology which has been used in all efforts to improve human conditions from the earliest time. It has been found that men can often be influenced in a group as they cannot be influenced by appealing to them individually. Group meetings, however, should not be relied on to the exclusion of personal work in safety.

A meeting of all the employes in a plant is usually the most effective means of quickly acquainting the employes with the fact that a campaign is to be inaugurated. Such a meeting presents a good opportunity for the manager to express to his employes his own personal interest in the effort, his willingness to do everything in his power to make the plant safe and to protect the life and limb of the employes. At this initial meeting the accident experience of the previous year should be presented and the cost of the more serious accidents—in terms of dollars as well as human suffering—should be pointed out. Emphasis should be placed upon the fact that only a small percentage of the accidents could possibly have been prevented by any mechanical guard or equipment; that if, in the future, such accidents are to be prevented at all they must be prevented by the carefulness of the workmen. At this meeting the manager should carefully outline each feature of the accident prevention program, pointing out especially those features in which the workmen are to take an active part. He should also outline the experience of other companies and give figures showing substantial reductions which they have made in deaths and serious injuris. He should emphasize the point that the program for the campaign just starting had been worked out along lines which had proved successful in these other companies.

Those who are familiar with the effect of political meetings or who remember the meetings of the war time period, will understand how effective the properly managed workmen's meeting can be in arousing enthusiasm and a spirit of cooperation. A wholesome competitive spirit, with attendant feelings of pride and loyalty often can be aroused only in this way.

These things are essential in an accident prevention campaign. It is not sufficient to make workmen realize that injuries will mean loss and suffering to themselves and to their families. It is important, also, to make the men eager to have a better record than the men in other departments, or in other plants or other companies. It is this feeling which, as much as fear of the personal consequences of injury, has made it possible for many large plants to go for months without a single accident resulting in loss of time. When all the men in a department are striving to make a perfect safety record in competition with other departments, a man will be ashamed, before his fellow workmen, to spoil the record by having an accident. And he will be careful.



General view of Louisville Refining Company's skimming and cracking plant at Louisville, Kentucky

Low Cost Processing Effected in Plant Of Louisville Refining Company

By GEORGE REID
Associate Editor

AFTER extensive improvements and additions to the essential distillation and cracking plant equipment and other departments, the Louisville Refining Company at Louisville, Kentucky, began operating its modern skimming and cracking plant in May, this year. It will be recalled that this plant was erected by the Louisville Petroleum Refining Company and was originally a cracking plant consisting of two Dubbs units and a shell still for redistillation of the pressure distillate. Later a Winkler and Koch tube still with two bubble towers and conjunctive equipment was added. The present owners started improving the distillation system and other parts of the process immediately after assuming control of the plant, with the result that many interesting features of economy and control are now incorporated in the plant design.

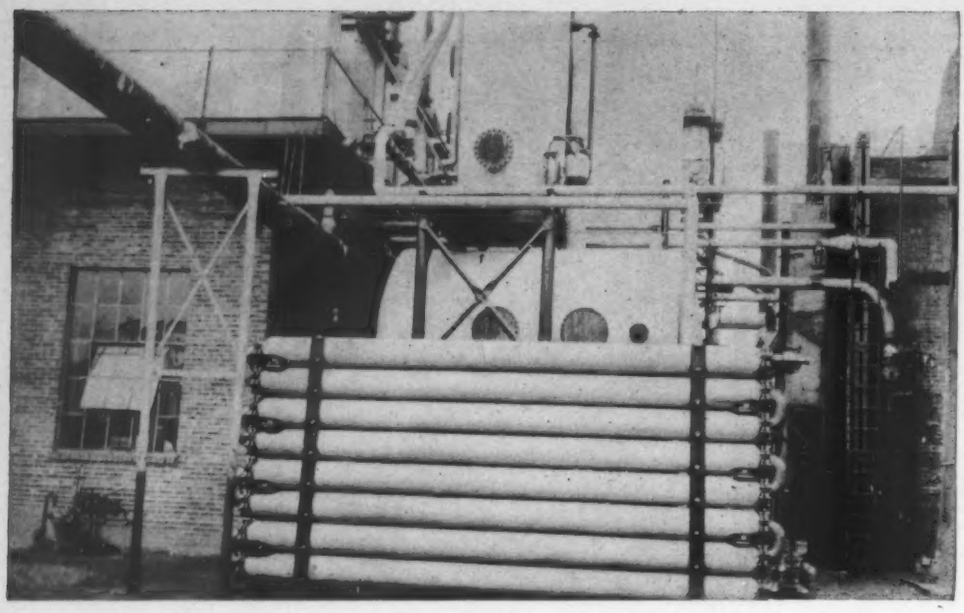
In describing the present efficient installation it will be well to follow the crude flow through the system. One of the first prerequisites in refining operations along modern lines is the reduction of costs of processing throughout the entire system. When C. A. Jouett, general superintendent, started the program of improvement and enlargement of plant capacity, he followed the modern practice of recoving as great a percentage of the available gasoline through the utilization of waste heat as possible, At present 35 per cent. of the total gasoline produced in the skimming operation is removed from the crude before the oil reaches the tube still.

Crude entering the plant cold is pumped by a Union Steam duplex pump size 9x5¼x10 inches, through control sections mounted at the top of the four bubble towers, where it is preheated to a temperature of 300 to 310 F. The oil then passes through a Vogt heat exchanger countercurrent to the residuum leaving the vaporizor tower, and it is increased in temperature at this point to 350 to 360 F. Since the skimming plant removes about 42 per cent of the lighter products, including 1 or 2 per cent. kerosene, this final exchange of heat effecting an increase in temperature of about 50 degrees is with but approximately 58 per cent. of the crude charge. Fresh oil is charged at the rate of 3200 to 3500 barrels daily. A back pressure of about 125 pounds is built up in passing the cool crude through the control sections and exchangers.

Leaving the heat exchangers the preheated crude then is flashed into the first bubble tower at about one-third of its height and from this tower the first stream of gasoline, consisting of 35 per cent of the total available motor fuel by skimming, is removed through condenser and receiving house, at about 61 gravity.

PIPE STILL OPERATION

Crude descends to the bottom of this tower and is picked up by the second pump and discharged into the top bank of tubes in the pipe still. This tube bank is exposed to the coolest gases of combustion and the flow is so regulated that the temperature of the oil passing through them is raised to 400 F. The crude at this temperature is taken out of the pipe still and conducted to the second bubble tower and handled in the same manner as described in regard to No. 1 tower. The gasoline



View of Vogt heat exchanger. Also shows residuum accumulating drum behind exchanger from which a small cut of kerosene is flashed

vapors liberated at this point are conducted to condenser and storage at approximately 58-59 A. P. I. gravity.

The crude accumulates in the bottom of No. 2 tower and is again picked up by pump and sent to the pipe still. This time it passes through the hottest zone and the temperature is raised to 625-650 F. The second and third hot oil pumps are Vogt. They are controlled in operation by Tagliabue controllers, maintaining a constant level of oil in the bottom sections of the two bubble towers. Crude leaving the lower bank of tubes in the still is conducted to the third of the large bubble towers where a stream of 49 gravity naphtha with motor fuel end point suecifications is removed to condenser and storage. This product is marketable as a special naphtha or it is blended back into the common gasoline derived from the skimming operation—all of which is later blended with cracked gasoline to meet certain anti-knock requirements.

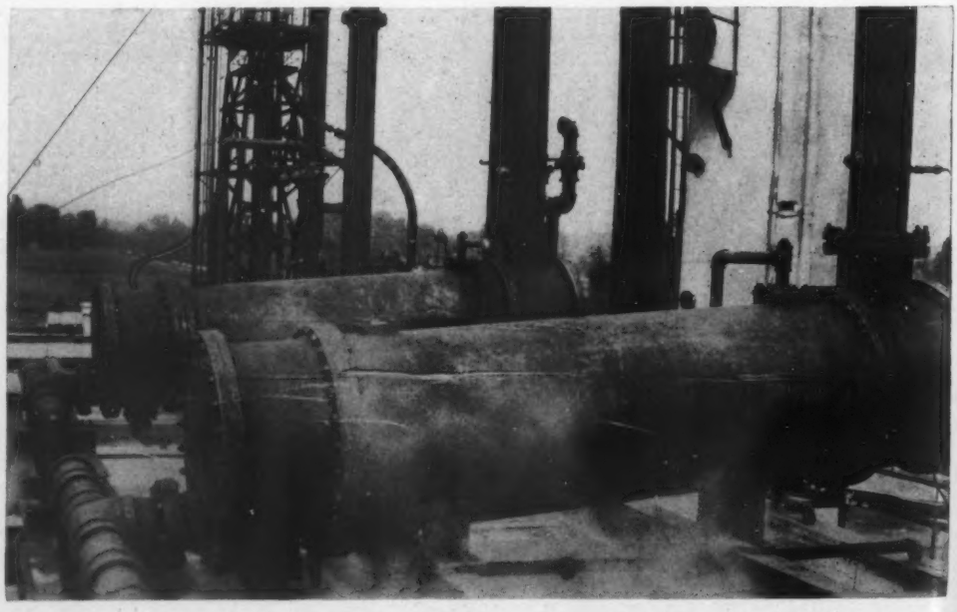
This third tower refluxes into a residuum drum which is surmounted by a smaller bubble tower. As it enters the drum it is flashed with steam and a small percentage of kerosene is taken off of the top of the small tower. This tower refluxes back into the residuum drum, or it is so equipped that a stream of excellent gas oil for cracking plant charging stock or furnace fuel can be removed from the bottom. However, since the company charges fuel oil to its Dubbs units, it cracks the gas oil along with the fuel without separation. The residue from the residuum drum passes through the Vogt heat exchanger and direct to Dubbs charging stock storage tanks. The residuum thus prepared has an average gravity of about 23.5 A. P. I.

CONTROL EQUIPMENT

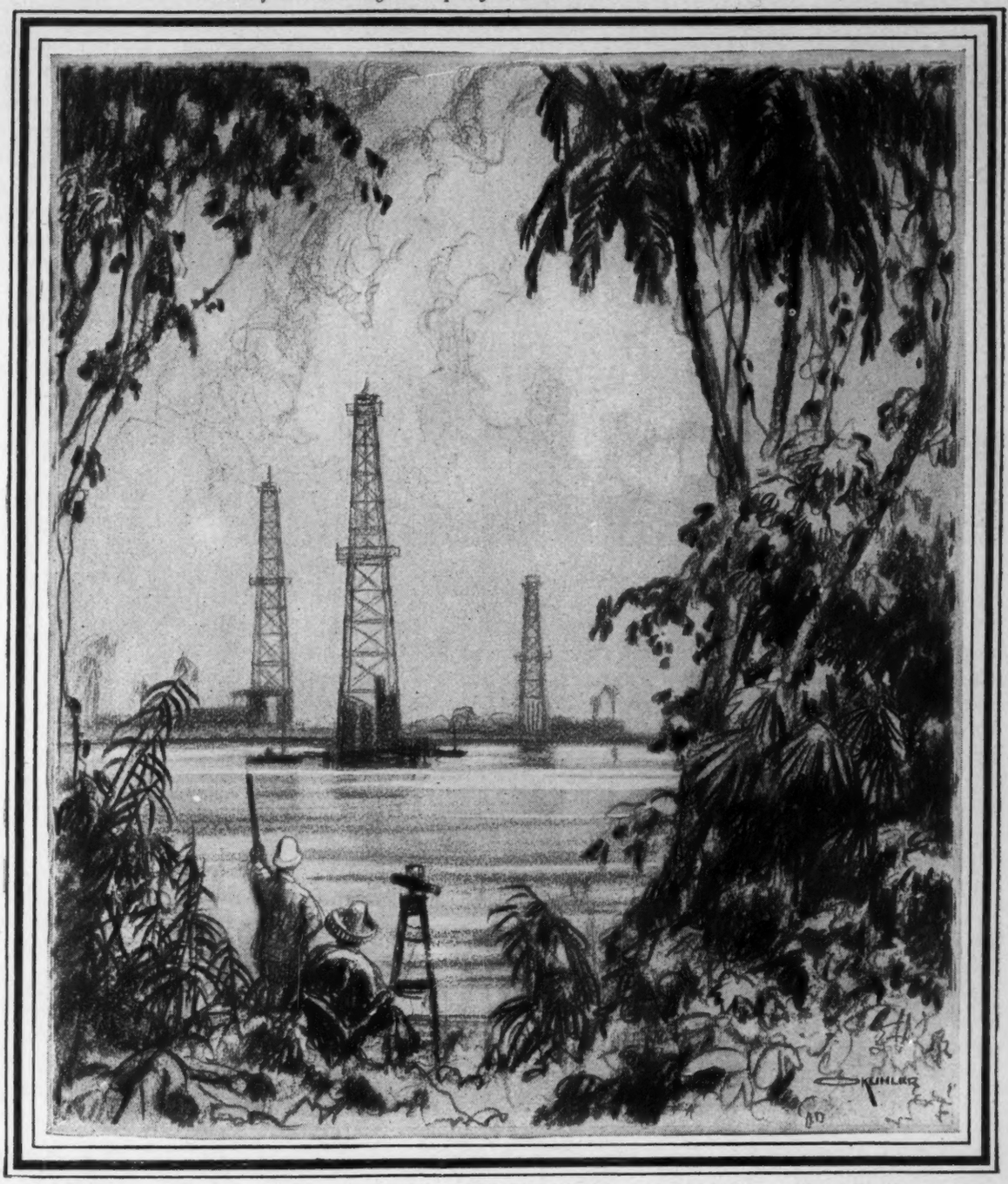
In addition to the control instruments governing the speed of the two charging pumps as mentioned, many other control and recording devices are provided tending to higher efficiency and ease of still operation. The fourth pump is utilized to handle hot residuum through the exchangers and storage. Recording instruments make a graphic picture of the entire plant operations. Temperatures are shown of the vapors leaving Nos. 1, 2, 3 and 4 towers. The temperature of the crude oil as it leaves the control sections at the top of the towers; as it leaves the Vogt heat exchangers; as it leaves the top bank of tubes, and as it leaves the lower bank of tubes, is shown in chart record form. All of the towers are provided with a number of points of entry for the heated oil so that better control of the tower operation can be secured.

The Winkler and Koch tube still is provided with adequate control devices as to draft and firing. The still consists of 118 tubes, 4-inch O. D. and 30 feet long. With a furnace temperature of 1500 F. it has a stack temperature of but 350-360 F., which speaks well for its design and the method of operation.

Through an ingenious arrangement of valves, checks and manifolding, the volume of crude going from the first pump through all of the control or preheating sections at the top of the towers, is readily and easily controlled and once set for operation at desired tempera-



Pressure distillate charged through control section at top of bubble tower and through these two vapor heat exchangers, is injected into the tower at nearly 200 F.



CRUDES FROM ALL OVER THE WORLD COME TO THE KELLOGG WAREHOUSE

From Russia and Japan – Persia and Argentine – Mexico and Venezuela and from the oil fields of the United States, the Kellogg Warehouse receives samples of crudes of widely different characteristics. Laboratory runs of these crudes, checked with infinite care at every stage, place in the possession of Kellogg oil technologists accurate information about the peculiarities of crudes from every land.

The world-wide scope of the experience of the Kellogg engineering organization, supplemented by manufacturing facilities which are equal to any demand that may be made upon them, are in a large measure responsible for the success of Kellogg refinery equipment.

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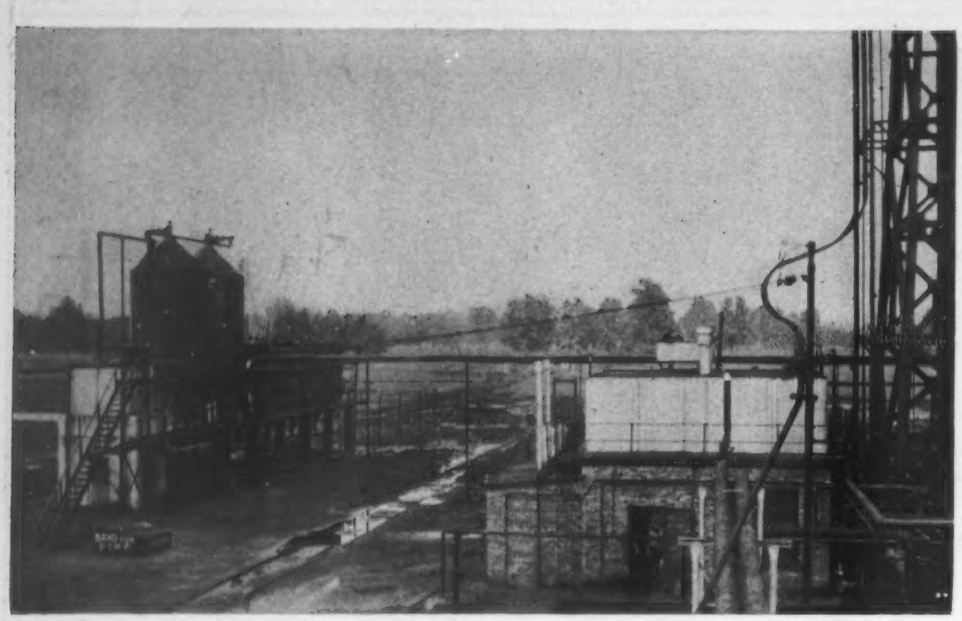


View of flashing system made by plant operators. The tar is used for firing stills.

tures none of the valves needs further attention. It consists of valves so placed at each tower that just the right amount of cold oil passes over them to secure the desired results in so far as stream specifications are concerned, and is accomplished by a series of block and by-pass valves so placed that the oil passes through the control sections progressively in just the right amounts and is united into a single stream for transfer to the final heat exchanger, from where it passes into the first bubble tower to yield a large proportion of its light gasoline, as mentioned previously.

Each of the bubble towers are provided with small pet cocks opposite each alternate tray or plate by means of which the stillman can determine the condition of each tower throughout its height. Opening the pets gives indication as to whether or not the tower is surging. Glass gauges are provided at the bottom of each tower in which liquid accumulates so that the stillman can see what his levels are at all times and thus check against his control devices. All of the bubble decks are provided with a number of quarter-inch holes in order that the towers may be completely drained whenever the plant is shut down.

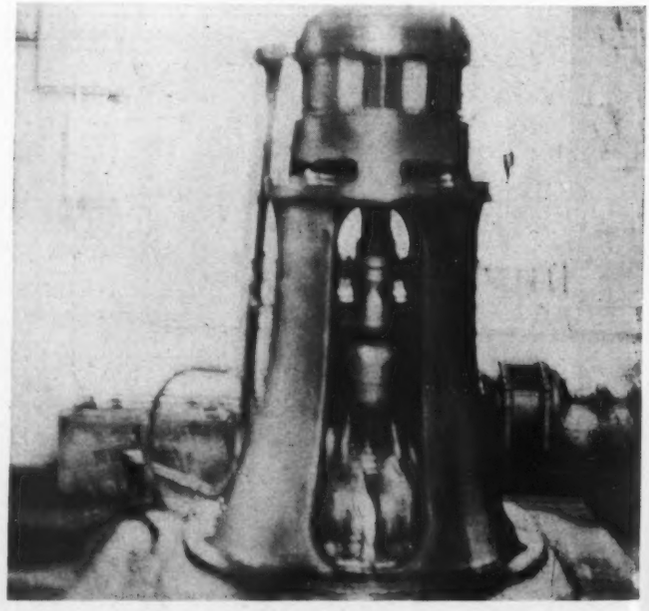
FUEL CONSUMPTION LOW

The tube still operation effects a skimming recovery of 40 per cent. gasoline from Western Kentucky crude of 35 gravity. The total over all recovery of the plant, both cracking and skimming, is given as 68 per cent. Losses are carefully guarded against and in addition to gasoline recovery plant, vapor tight tanks, etc., the run-down lines carrying gasoline from receiving house are insulated against heat from the sun. The tube still operation is economical in the matter of fuel, requiring a little less than 2 per cent. for efficient operation in the manner described in the foregoing discussion.

Rerunning pressure distillate after chemical treatment is accomplished through one shell still, operating continuously and in this procedure much of the actual heating for distillation is performed before the oil reaches the still. The distillate is charged through two O. S. Sleeper vapor heat exchangers installed on the vapor lines leaving the single tower and located above the condenser boxes as shown in an accompanying illustration. Two vapor lines are used which conduct the vapors to separate condenser boxes in order to provide adequate condenser surface; greater possibilities through vapor heat exchange, and to make possible continuous operation in the event of leaks occurring in either of the condenser boxes.

The oil, or pressure distillate, in passing through these two exchangers is preheated to 190 F. In addition to this heating the charged oil passes through a Sterling control section mounted in the top of the bubble tower before it reaches the vapor exchangers. Leaving the preheating equipment the hot oil is flashed into the middle of the large tower. This fractionating column is 8 by 60 feet in dimensions and is equipped with five bubble trays in the uppermost part and packed with rock in the lower sections. This packing runs from 1¼ to 3 inches in size. By far the greater proportion of gasoline is removed in the tower. The heavier portions reflux back into the shell still which is held at a constant temperature of 400 F.

Another item of economy is noted in the operation of the shell still. All four of the pumps handling oil for the pipe still work pass their exhaust steam into a header from where it is conducted to coils inside of the shell still. This system effects a marked decrease in the amount of live steam requirements for running the pressure distillate. A very small fire only, is required for maintaining the temperature of the shell still. This



Electrically driven vertical centrifugal pump over well hole delivery water for all plant purposes continuously at 55 F.

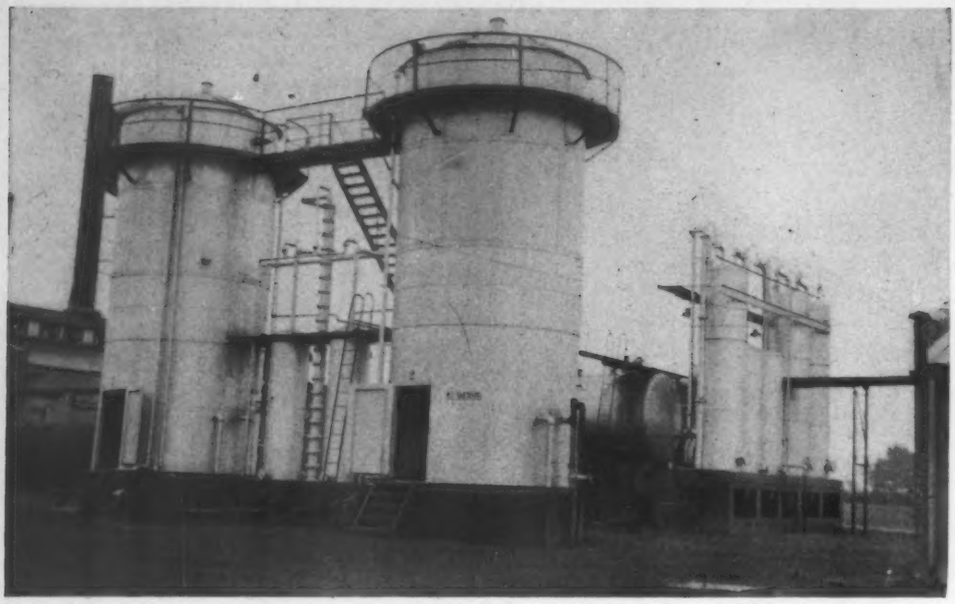
From an article by C. O. Willson in
The Oil and Gas Journal, issue of November 15, 1928

"As has been the case for several months, a number of refiners are running considerable fuel oil to storage. Based on today's markets, this fuel oil, if it is suitable for cracking, is worth approximately twice present quotations as raw material in the manufacture of gasoline."

It is *all* suitable for cracking—and it is worth from a third to one-half more, if it is cracked by the Dubbs Process rather than by any other method, because of the greater gasoline yield and lower operating cost

Universal Oil Products Co
Chicago, Illinois

Dubbs Cracking Process
Owner and Licensor



View of treating plant assembly showing mixer for treating pressure distillate with acid between the agitators, and continuous gasoline treater to right background

single still and bubble tower have a capacity of 900 barrels daily of pressure distillate and by virtue of accurate control the operation is almost automatic. The still bottoms, which have an initial boiling point of 450 F., after the removal of 437 end point gasoline, are pumped to storage and marketed as stove or engine distillate for which a brisk market prevails for both domestic and industrial consumption.

COMBATING CORROSION

Another interesting feature is found in the arrangements made for washing the rerun still bubble tower, condenser, and lines. In redistilling pressure distillate a certain amount of corrosion and products of corrosion are always present. The Louisville Refining Company retards the inroads of the corrosive compounds and lengthens the life of its equipment by periodically washing the accumulations out of its equipment with warm water from the pit. The towers, condensers, and run-down lines are equipped with block valves at the receiving house, on the run-down lines just outside of the house proper, on the reflux lines where they leave the tower and on the vapor lines as they leave the still. When these valves are closed the fractionating and condensing equipment is segregated from the shell still. There are two 12-inch gate valves on the vapor line at the still with a small bleeder line placed between them, through which any water or oil in the line is removed before or after washing.

To wash the system and clean it of the greater portion of the products and accumulations due to corrosion, the water is charged into the system at the bottom of the tower through the reflux line. It is carried away from the system through a four-inch line leading from the run-down line near the back of the receiving house. This washing eliminates plugging of the tower equipment as well as prolongs its length of service. The quarter-inch holes in the bubble decks assist in draining the water or oil from the bubble tower before and after washing. The entire system can be thoroughly cleaned in a very few hours in this manner. Washing water is conducted to the slop trap from the system and any oil left in the coils is reclaimed.

When the present operators took over the plant a system of settling tanks had been installed in which the residuum from the Dubbs cracking units was caused to settle in an effort to separate the suspended carbon particles from the residual oil. This consisted of a battery of eight cone bottom tanks. Mr. Jouett and G. C. Hatfield, his assistant, decided to install a flashing system instead of the settling method, so they took four of the old settling tanks and riveted them together in pairs, thus preparing a flashing system at very little cost. The details of this installation are shown in one of the accompanying pictures. The residuum is drawn off of the Dubbs chamber continuously to flash into one or the other of the home made flashing chambers, as shown. Steam is passed into the drag line continuously, and when the steam and heavy residue reach the flash tanks a steam of gas oil is flashed to condensers and cooled, which is either recracked or marketed as furnace oil.

Another feature of economy of plant operations is found in the system installed for burning the heavy tar secured from the flashing operations. Two Worthington pumps, size 10x4½x10, hot oil design, one of which is standby equipment, handle the hot tar from the flush tanks to the burners. An extra heavy 1½-inch line leads from the pumps to the Dubbs furnace burners, to rerun still fires, and to the pipe still burners, and back again to the tanks. The pumps handle this heavy tar at 600 F., building up a pressure at the pump of 100 pounds. Further fuel economy is shown in the utilization of Dubbs unit gases for firing boilers when the cracking units are in operation. Three of the four Walton 150 h.p. boilers are equipped to burn this gas, or oil, and the fourth is fired with coke.

WATER SUPPLY

An abundant supply of cool water is provided from a single well located in the center of the plant yard. The well is 120 feet in depth and water produced has a year-round temperature of 55 F. A Layne & Bowler vertical centrifugal pump, electrically operated, pumps the well continuously at the rate of 600 gallons per minute. The pump is equipped with a bell signal which rings automatically whenever the pump stops for any reason, calling the stillman's attention to this trouble.

This water is used in the condenser boxes for cooling, in all of the hydrants, lavatories, and by the treating department. A large reservoir on the plant yard contains sufficient water reserve for plant operation in the event of failure of electricity. In addition a 6-inch city water main furnishes water to the plant if needed. One condenser box is supplied with this city water, where it

PIPING BY MIDWEST

Dubbs Stills at Parco Refinery of Producers and Refiners Corp.

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Midwest is now also erecting piping of all kinds. This results from the acquisition of a contracting organization that has had more than 30 years' experience in piping erection.

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is warmed for use in the boiler house, since it is not necessary to treat the city water for boiler use.

Pressure distillate is acid treated in batch agitators using a semi-continuous system of company design. The acid and pressure distillate are mixed in the proper proportions and forced through a mixing device which consists of 20 orifice plates alternating in respect to the number and size of the orifices. By the time an agitator is charged through this mixer at the rate of 125 barrels per hour, it is treated. The flow is then turned into the second agitator. Acid is drawn off the first agitator and a small amount of caustic is used for neutralization with but two or three minutes blowing. Losses are very low.

Straight run gasoline from the pipe still requires very little chemical treatment. The cracked gasoline from the rerun still is fairly stable, and requires but a little stabilization wash with caustic solution in a second continuous treater to make it stable in storage and sunlight. The two grades of gasoline are kept in separate storage and are mixed at the loading rack at time of shipment. The gasoline treating system consists of five treating columns. Gasoline and caustic are mixed before entering the first treating or settling tower, and treating is carried out in the usual manner. The treating plant is well lighted for night work with more than the usual safety devices installed.

Crude oil for processing at this plant is derived from the Western Kentucky fields, mostly from the Weller pool in Ohio County. The Producers Pipe Line Company of which J. Fred Miles is general manager as well as general manager for the refining company, delivers the oil by pipe line from the field 22 miles to Owensboro, on the Ohio River, to two 38,000-barrel tanks. From these tanks the oil is loaded by gravity flow at the rate of 1500 barrels per hour, into oil barges having a capacity of 5000 barrels each. Three of these barges are towed up the river at one trip for a distance of 132 miles to the refinery. They make an average of nine trips per month. At the plant the barges are unloaded into 55,000-barrel tanks by electrically driven centrifugal pumps at the rate of 1000 barrels per hour. The recent enlargement program at the plant makes possible the processing of 115,000 to 125,000 barrels of oil monthly.

Factors Involved in Construction And Operation of Gas-Holders

MANY refiners have installed in their plants, and are finding same an economic benefit, holders for storage—until used—of gas from which the gasoline has been extracted in the refinery, gasoline-recovery plant. In view of the fact that refiners more and more are endeavoring to develop vapor-phase cracking processes, by which relatively large percentage proportions of gas are made, it naturally follows that an increasingly greater number of refiners are going to be interested in the future in the advisability of installing gas-holders, assuming that such holders are not already constructed and in use in those plants. The purpose of the present discussion, therefore, is to present some of the most important factors involved in the construction and operation of containers for storing gas.

FUNCTION OF GAS HOLDER

A gas holder in a refinery represents an economical means for storing gas until it can be used. Much of this gas otherwise would be wasted. In other words gas is stored in the holder during "peaks," when an excess quantity of gas is being made, for subsequent use when there is a lesser amount being obtained from the light-oil storage tanks and from the distillation and other refinery processes during the functioning of which gas is given-off. Most companies use this gas as refinery fuel; a few sell it to public-service companies for use in enriching water gas; while it is not ridiculous to predict that eventually a large amount of such gas will be used in the synthesis of numerous chemical compounds, iso-butyl and iso-propyl alcohol already being among those products that are now obtained from pressure-still gases.

In addition to functioning for the storage of gas, gas-holders also aid in the distribution of the gas as it is used in the refinery for fuel. The weight of a gas-holder fully inflated, or even only partly inflated, exerts a pressure upon the gas. This pressure can be and is used to force the gas into the distribution system. A holder fully inflated with 5,000,000 cubic feet of gas in it exerts a pressure upon the gas of approximately one-half pound per square inch. This pressure varies according to the height of the holder: that is, as the holder falls and each section is "landed," the weight of metal suspended becomes less and, therefore, the pressure exerted upon the gas contained therein is less. This principle of the pressure exerted by the holder is taken advantage of as much as possible in the distribution of gas within the refinery. Where the holder pressure is not sufficient to deliver the required volume of gas, "boosters" are installed to draw the gas from the holder and "boost-it-up" to the required pressure. However, even under such conditions (if deemed advisable) the holder-pressure can be utilized by distributing the gas through a separate outlet-connection to process or power units (stills or boiler-houses) closest to the holder, and for the accomplishment of which the existing holder-pressure *will be* sufficient.

Figure 1 shows the general features of a gas-holder.

A gas-holder consists of a tank for the storage of water, one or more "lifts" arranged to telescope one

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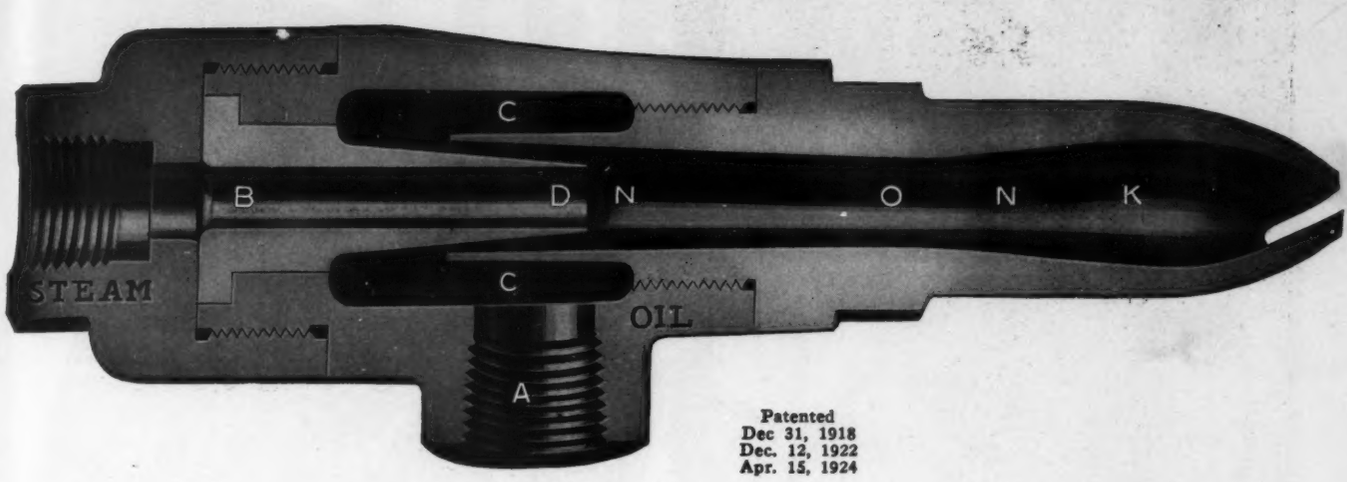

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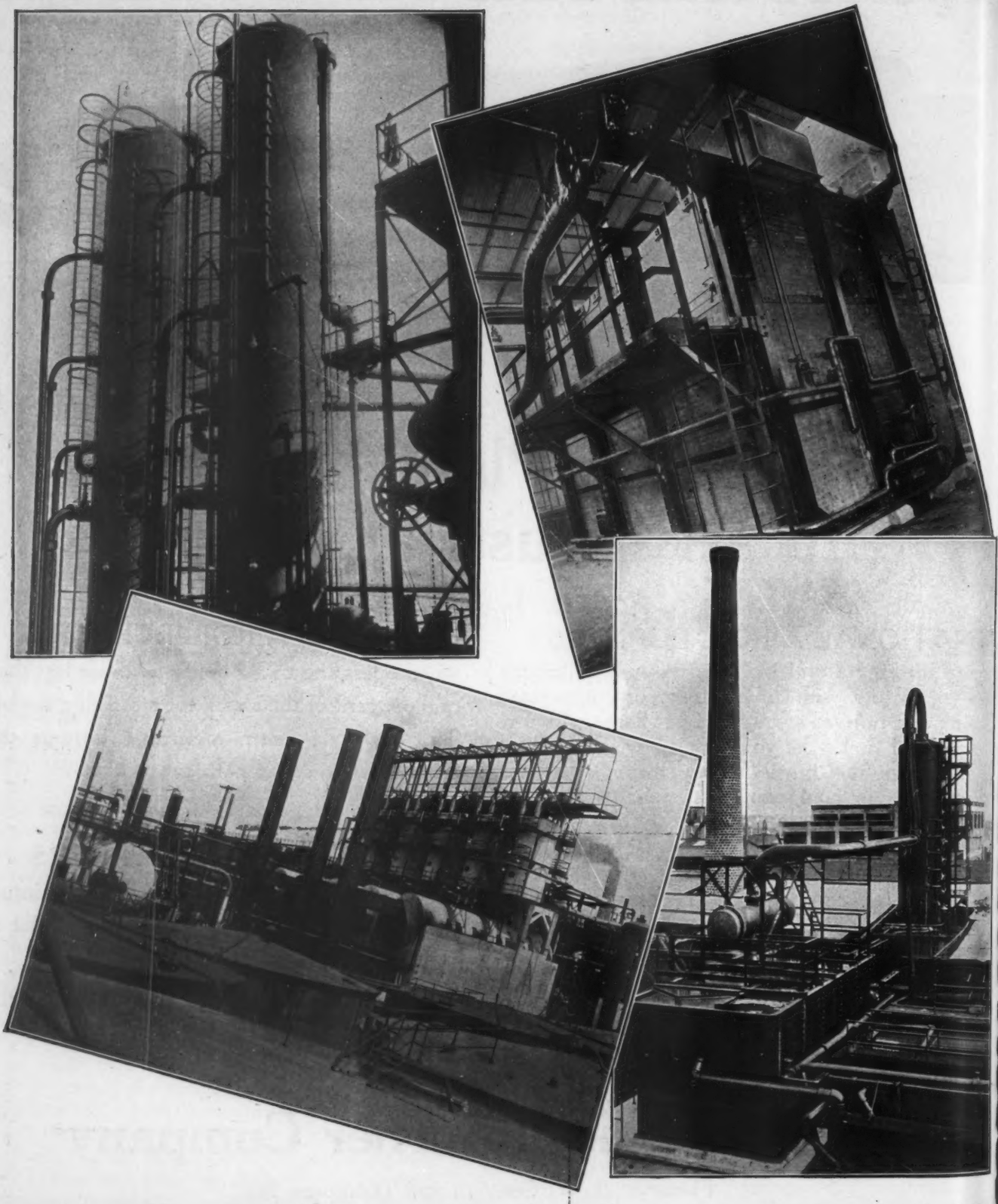

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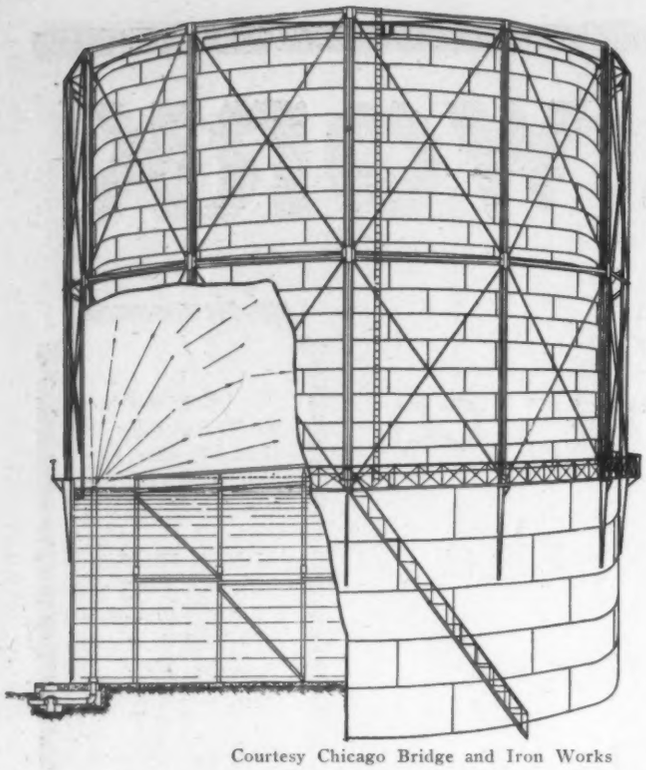

Courtesy Chicago Bridge and Iron Works

This drawing shows the general features of a gas holder. Note the water tank, interior timber support, inlet pipe, etc.

into the other as they rise and fall, and a suitable framework made up of a number of columns placed circumferentially around the holder at distances from 15 to 30 feet apart. The columns are adequately braced by horizontal girders and diagonal ties. The girders are built up from steel sections. On small holders, the ties are rods; on large holders, angles or chains. The inside of the columns form a path for the wheels on the goose-necks. Such an arrangement provides a guide for the rise and fall of the lifts and, in addition, also prevents any rotating movement.

DESIGN AND CONSTRUCTION

The design of a gas-holder presents many problems that must be solved. The holder must resist the pressure exerted by the strongest winds. It must be so designed as to carry the additional weight due to heavy snows. Further, the tank walls must be of sufficient thickness as to resist the pressure of the water contained in the tank.

For a detailed description of the manner in which a gas-holder is designed and constructed, the interested reader is referred to an article, "Construction Details for Holder for Uncondensable Still Gases," in the August, 1927, issue of The Refiner and Natural Gasoline Manufacturer. In that article was described a gas-holder as constructed at the Parco, Wyoming, refinery of Producers and Refiners Corporation.

HOW A GAS-HOLDER OPERATES

In the operation of a gas-holder, the tank of the holder is first filled with water to provide a seal for the gas. In the case of multiple-lift holders, which are required when a very large volume of gas storage is needed, each succeeding section from the bottom up is smaller in diameter than the one next below it, so that each section telescopes within the section immediately below it. The lifting and sealing of each section with the section adjacent to it is accomplished by means of "cups" and "grips."

The cup on the bottom of each section is turned outward and up; while the grip on the top of each section is turned inward and down. As gas is put into the holder, the inner section rises. Thereafter, when it has traveled its own height, its bottom cup engages with the top grip of the next outer section, picking up this section and lifting it as it continues to rise. Since each cup is water-tight, the cup carries water with it while being lifted out of the water, this water providing a seal to prevent the gas from escaping. The depth of these cups is regulated by the amount of pressure exerted by the contained gas, being so designed that there will be a sufficient head of water in each cup to prevent any gas from blowing through.

The inner or top section is the only one having a covering. This cover or "crown," as it is called, is fastened to the sides by means of curb angles and is braced so that the weight of the metal in the crown is adequately supported by the side plates. Timber framework is usually erected within the tank of the holder so that, when the holder is empty and "landed," the weight of the crown rests upon this timber support. The main connections of this timber support are bolted, so as to make a permanent construction.

Inlet and outlet pipes are provided for putting gas in and taking it out of the holder. These pipes are carried down under the foundation of the tank and up through and above the water. They are provided with drip connections at their lowest point, so that any water vapor that may be condensed can be removed.

HOW GAS-HOLDERS ARE HEATED IN COLD WEATHER

In climates having temperatures below freezing, provision must be made to prevent the water in the tank and cups from freezing. The usual method of heating holders is to place steam siphons in the tank and cups in such a manner that the water is kept in circulation at all times. The cold water at the bottom of the cups is lifted by the steam siphon and discharged at the top of the cups. The same principle is employed in the tank, in this case the siphon being designed so as to create a circulation of water to the deepest point of freezing. Hot water from other refinery equipment, if available in sufficient quantities, may be supplied to the tank and cups and thus save the expense of using steam.

The improved Burrell Gas Indicator marketed by the Mine Safety Appliances Company, Pittsburgh, Pennsylvania, serves to analyze for small quantities of known combustible gases in the air at the place where the sample is taken and for indicating the presence of an explosive concentration of a gas or a mixture of gases.

A recent bulletin published on this improved indicator describes in detail its operation, with special notes on the safety features, and may be obtained by writing the marketing company, Braddock Avenue and Thomas Boulevard, at Pittsburgh.

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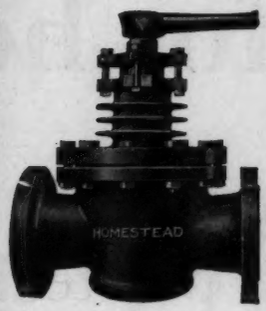

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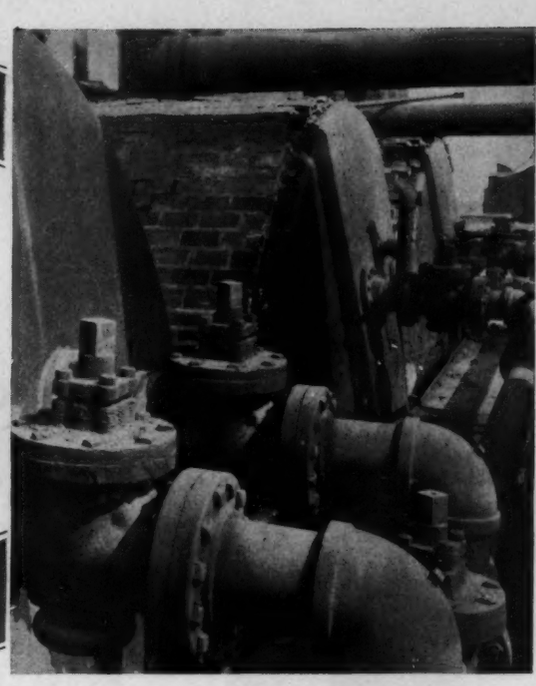

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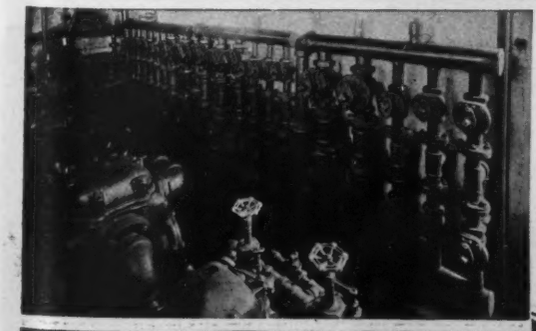

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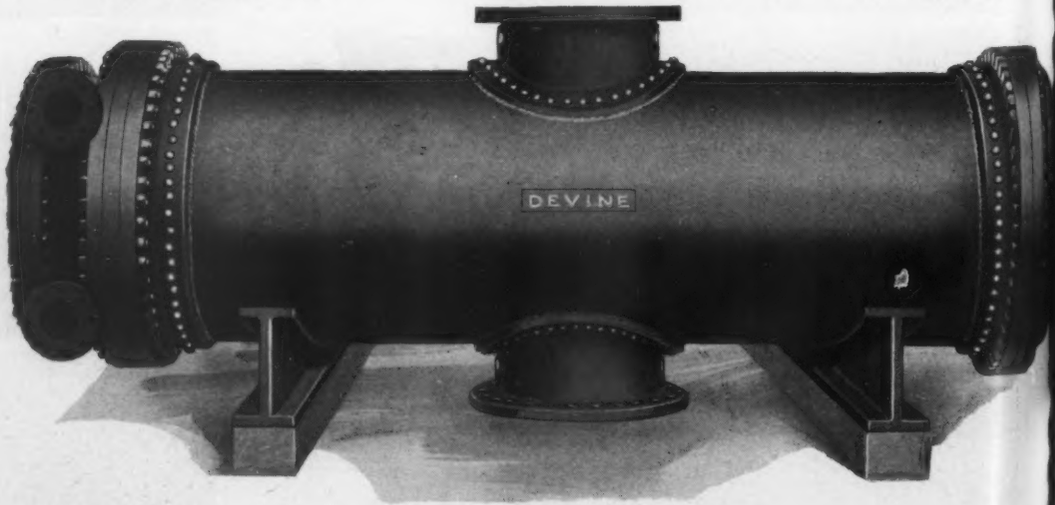

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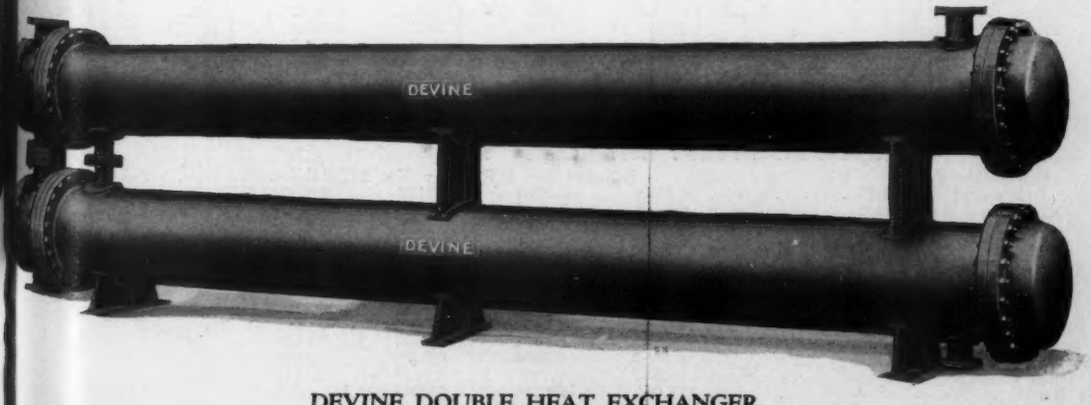

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Cost Data on Refining Light Oils

By H. L. KAUFFMAN

WHAT are the actual costs of refining light oils? With market conditions as they are at present, many refiners find themselves operating at a loss. Naturally, they are asking themeslves whether or not it is because of the inefficiency of their refinery equipment and method of operation or because of a condition of supply and demand that is beyond their control.

"What does it cost the large refiner with modern equipment to refine light oils?" is a question constantly asked by the smaller refiner. The answer to this question, which is the subject matter of the present article, it is believed, will be surprising or, if not, will at least present some interesting cost data.

Although the refiner whose operating costs are discussed in this article operates many refineries in various sections of the country, data on costs of operation on only seven of those refineries will be herein discussed.

Cost of Crude Stilling

Be low is shown the cost of distilling crude oil in shell stills at seven of the refineries operated by this company over four, recent, consecutive six-month periods. The costs shown represent cents per barrel.

Attention is called to the fact that the average cost per barrel for all plants for this last six-month period was $0.0789.

Ref. No.	First 6 months of 192	Last 6 months of 192	First 6 months of 192	Last 6 months of 192
1	$0.1243	$0.1141	$0.0930	$0.0876
2	0.1355	0.1566	0.1220	0.1059
3	0.0503	0.0485	0.0330	0.0387
4	0.0727	0.0613	0.0793	0.0604
5	0.1537	0.1025	0.1023	0.0776
6	0.1270	0.0822	0.1033	0.0756
7*	0.0700	0.0540	0.0530	0.0514

*Includes crude tube stilling .

Cost of Crude Tube Stilling

The average unit cost for distilling crude oil in pipe stills in the five refineries owned by this company in which this type of still was operated, during the last six-month period mentioned, was $0.0555 per barrel.

It will be noted that slight increases in crude tube stilling costs were made by refineries Nos. 3, 4 and 5 during the last six-month period over the previous period; refineries Nos. 1 and 6, on the other hand, made appreciable reductions.

The operating costs of crude tube stilling at refinery No. 4 increased (during the last six-month period) from $28,656.55 to $54,393.04, with a reduction in the amount of crude handled through the equipment of nearly 100,000 barrels. Part of this increase was due to the large amount of retirement loss charged to the operation, but it was also found that the operating expenses, labor and material, increased nearly $3,000.

The unit cost for labor, operating and repairs, at refinery No. 4 during the last six-month period mentioned was $0.0151; whereas, during the previous period it was only $0.0091.

The decided reduction in crude tube stilling costs at refinery No. 6, during the last six-month period, was due to the larger amount of oil handled through the equipment with lower expenses. The operating labor and repair expenses at this plant for this last period was only about $4,800.00 and the unit cost $0.0158; whereas, during the six-month previous, when the plant handled only 242,586 barrels of oil, this expense was $6,189.87 and the unit cost $0.0255.

Below is shown the cost per barrel of

TABLE 1

CRUDE STILLING— Refinery No.	1	2	3	4	5	6	7	Averge
Operating, Labor and Material	0.0091	0.0098	0.0055	0.0055	0.0131	0.0112	0.0096	0.0088
Repair, Labor and Material	0.0046	0.0031	0.0024	0.0058	0.0024	0.0028	0.0034	0.0039
Fuel	0.0376	0.0416	0.0153	0.0218	0.0308	0.0254	0.0203	0.0321
Steam, Power and Water	0.0199	0.0449	0.0044	0.0144	0.0120	0.0192	0.0140	0.0209
Chemicals	.....	.....	.....	.....	.....	0.0005	.....	0.0000
Changing Construction	0.0015*	.....	0.0015*	0.0001*	.0000	0.0004	.....	0.0005*
Retirement, Loss and Expense	0.0028	0.0000	0.0012	0.0013	0.0001*	0.0001*	.....	0.0015
Fire Loss Expense	0.0005*	.....	0.0001	0.0004	.....	0.0020	.....	0.0001*
Oil Recovery Department	0.0053	.....	0.0003	0.0002	0.0007	0.0006	.....	0.0025
Indirect Plant Expense	0.0103	0.0065	0.0080	0.0109	0.0187	0.0136	0.0041	0.0098
Total Plant Cost	0.0876	0.1059	0.0387	0.0604	0.0776	0.0756	0.0514	0.0789
Fixed and Overhead	0.0377	0.0195	0.0202	0.0313	0.0366	0.0533	0.0241	0.0316
Receiving, Storage and Distribution	0.0445	0.0680	0.0330	0.0471	0.0670	0.1384	0.0188	0.0510
Grand Total Cost	0.1698	0.1934	0.0919	0.1388	0.1812	0.2673	0.0943	0.1615
Barrels Run	7,760,542	2,901,104	2,062,839	1,608,727	919,594	742,354	1,097,999	17,093,159
CRUDE TUBE STILLING—								
Operating, Labor and Material	0.0056	.....	0.0059	0.0074	0.0106	0.0101	.....	0.0070
Repairs, Labor and Material	0.0019	.....	0.0022	0.0077	0.0050	0.0057	.....	0.0038
Fuel	0.0299	.....	0.0241	0.0236	0.0443	0.0218	.....	0.0278
Steam, Power and Water	0.0113	.....	0.0027	0.0034	0.0049	0.0126	.....	0.0064
Change of Construction	.....	.....	0.0011	0.0001	0.0001	0.0009	.....	0.0005
Retirement Loss Expense	.....	.....	0.0000*	0.0026	.....	0.0032	.....	0.0008
Indirect Plant Expense	0.0070	.....	0.0076	0.0085	0.0158	0.0152	.....	0.0092
Total Plant Expense	0.0557	.....	0.0436	0.0533	0.0807	0.0695	.....	0.0555
Fixed and Overhead	0.0266	.....	0.0188	0.0309	0.0299	0.0408	.....	0.0266
Grand Total Cost	0.0823	.....	0.0624	0.0842	0.1106	0.1103	.....	0.0821
Barrels Run	934,496	.....	1,091,101	644,903	391,490	306,221	.....	3,368,211

*Cred.

TABLE 2
RERUNNING PLANT DISTILLATE

Rerunning Outside Dist.	Refinery No. 1	Refinery No. 2	Total Ave.
Operating Labor and Material	0.0094	0.0092	0.0108	0.0092
Repairs, Labor and Materials	0.0049	0.0047	0.0041	0.0047
Fuel	0.0299	0.0344	0.0380	0.0345
Steam, Power and Water	0.0204	0.0197	0.0442	0.0200
Changing Const.	0.0019*	0.0012*	....	0.0012*
Retirement Loss Exp.	0.0007	0.0033	....	0.0033
Fire Loss Exp.	0.0004*	0.0003*	....	0.0003*
Indirect Plant Exp.	0.0110	0.0112	0.0075	0.0111
Total Plant Cost	0.0740	0.0810	0.1046	0.0813
Fixed and Overhead	0.0387	0.0378	0.0195	0.0376
Rec. Storage and Transporation	0.0455	0.0459	0.0676	0.0454
Grand Total Cost	0.1582	0.1639	0.1917	0.1643
Barrels Rerun	813,986	3,190,666	45,203	3,235,869

*Cred.

Check Up Your Valve Costs

Note down the hours, and possibly days, that you have lost in unproductive work, due to faulty valves which must be constantly repaired or replaced. Then figure out how much you are losing by using a valve of questionable value which you bought because it was "low priced."

Men who use Darling Valves say that their efficiency reduces losses in production to a minimum. They seldom need replacement—they last for years. Back of this superior performance are the years of skillful engineering—of untiring experimenting and of exacting workmanship with the best materials. These well known Darling qualities stand out uniformly because Darling tests *every* valve before it leaves the plant. Others are realizing a big saving by using the right kind of valve—you can do it, too.

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TABLE 3

Comparison of Treating Cost by Grades of Oil—Last Six Months 192—

	Refinery No. 1			Refinery No. 3			Refinery No. 3			Refinery No. 4			Refinery No. 5			Refinery No. 6		
	Cost Chemicals	Other Costs	Total	Cost Chemicals	Other Costs	Total	Cost Chemicals	Other Costs	Total	Cost Chemicals	Other Costs	Total	Cost Chemicals	Other Costs	Total	Cost Chemicals	Other Costs	Total
Cost per bbl Naphtha Distillate																		
"319" Auto Gasoline	....	....	....	....	....	....	0.0108	0.0299	0.0407	....	....	....	....	....	....	....	....	....
Naphtha Distillate	0.0284	0.0320	0.0604	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
V. S. Naphtha Dist. "A"	0.0495	0.0320	0.0815	....	....	....	0.0187	0.0299	0.0486	0.0170	0.0477	0.0647	0.0223	0.0717	0.0940	....	....	....
V. S. Naphtha Dist. "B"	0.0282	0.0320	0.0602	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Untreated Gasoline	0.0066	0.0320	0.0386	0.0010	0.0214	0.0224	0.0066	0.0299	0.0365	0.0119	0.0477	0.0596	0.0056	0.0717	0.0773	....	....	....
L. R. Cement Thinner	0.0211	0.0320	0.0531	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Steam, U. S. Naphtha Dist. B	....	....	....	....	....	....	0.0000	0.0299	0.0299	....	....	....	....	....	....	....	....	....
Total	0.0308	0.0320	0.0628	0.0010	0.0214	0.0224	0.0126	0.0299	0.0425	0.0147	0.0477	0.0624	0.0155	0.0717	0.0872	....	....	....
Burning Oil Distillates																		
40/41 W. W. Dist.	0.0354	0.0526	0.0880	0.0312	0.0436	0.0748	0.0147	0.0611	0.0758	0.0263	0.0872	0.1135	0.0322	0.1442	0.1764	....	....	....
Unsteamd 40/41 W. W. Dist.	0.0512	0.0526	0.1038	....	....	....	0.0619	0.0611	0.1230	0.0225	0.0872	0.1097	0.0384	0.1442	0.1826	....	....	....
Steamed W. W. Dist.	0.0384	0.0526	0.0910	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
300 Oil Stock	0.0982	0.0526	0.1508	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Standard White Stock	0.0456	0.0526	0.0982	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
300 Oil Dist.	0.0571	0.0526	0.1097	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Total	0.0418	0.0526	0.0944	0.0312	0.0436	0.0748	0.0215	0.0611	0.0826	0.0259	0.0872	0.1131	0.0346	0.1442	0.1788	....	....	....
S. W. A. & S. W. P. Dist.																		
S. W. A. Dist.	0.0439	0.0574	0.1013	....	....													
S. W. P.	....	....	....	....	....													
Total	0.0439	0.0574	0.1013	....	....													

COMPARISON OF STEAM STILLING COSTS

	Refinery No. 1			Refinery No. 4		
	Steam P. & W	Other Costs	Total	Steam P. & W.	Other Costs	Total
Naphtha Distillates	0.0964	0.0868	0.1832	0.0221	0.0980	0.1201
Burning Oil Distillates	0.0136	0.0712	0.0848	....	....	....
Cost per Bbl.						

crude tube stilling at the refineries indicated for each of four, consecutive, six-month periods:

Ref. No.	First 6 months of 192	Last 6 months of 192	First 6 months of 192	Last 6 months of 192
1	.....	0.0722	0.0701	0.0557
3	0.0457	0.0348	0.0360	0.0436
4	0.0396	0.0386	0.0389	0.0533
5	0.1032	0.0643	0.0785	0.0807
6	0.1916	0.0570	0.0907	0.0695

Unit of Cost of Steam Stilling

Only refineries No. 1 and No. 4 found it necessary to steam still their products during the last six months indicated, both of which reduced their unit costs of steam stilling very greatly. During this period there was steam stilled 2,048,001 barrels of oil with an average unit cost of $0.0673.

The main reason for the large decrease in operating cost at refinery No. 4 was on account of the low charges for steam, power and water.

Below is shown the cost per barrel of steam stilling at the refineries indicated for each of four, consecutive, six-month periods:

Ref. No.	First 6 months of 192	Last 6 months of 192	First 6 months of 192	Last 6 months of 192
1	0.0637	0.1217	0.0851	0.0675
3	0.0648	0.0394	0.0181	.....
4	0.0847	0.0796	0.1177	0.0583

Cost of Treating Light Oils

During the last six-months mentioned there was treated in the company's refineries 10,336,940 barrels of light oils.

From the figures given below it is to be noted that refinery No. 1 reduced the unit cost of treating consistently during each six-month period and that, during the last period, refinery No. 4 also brought the unit costs far below previous costs. Attention is called to the fact that a more valuable comparison could be obtained by separating the costs of treating naphtha distillates from the burning oil distillate costs.

Ref. No.	First 6 months of 192	Last 6 months of 192	First 6 months of 192	Last 6 months of 192
1	0.0912	0.0637	0.0550	0.0487
3	0.0161	0.0159	0.0158	0.0167
4	0.0475	0.0402	0.0405	0.0238
5	0.0405	0.0375	0.0352	0.0356
6	0.0425	0.0472	0.0434	0.0478

Below is shown the cost of treating light oils at each of the five refineries operated by this company where such oils are treated for each of four, consecutive, six-month periods:

Cost of Chemicals Used In Treating

The tabulation below gives the unit cost of chemicals used in treating naphtha and burning oil distillates during the last six-month period mentioned, which costs are much lower than the costs for chemicals during the previous period:

Refinery No.	Naphtha Distillate	Burning Oil Distillate
1	$0.0308	$0.0418
3	0.0010	0.0212
4	0.0126	0.0215
5	0.0174	0.0259
6	0.0155	0.0346

Cost of Compression Gasoline

The average unit operating cost of compression gasoline made at all refineries for the last six-month period mentioned was $0.3786 per barrel, while during the last month (December) of this period this cost was reduced to $0.295 per barrel.

Data on the unit operating cost of making compression gasoline at the refineries mentioned for this last six-month period are shown below:

Refinery No. 1 ..... $ 0.4064
Refinery No. 3 ..... 14.1236*
Refinery No. 4 ..... 0.2426
Refinery No. 5 ..... 0.5661
Refinery No. 6 ..... 0.7085

*This is abnormal and is due to the small quantity made.

Tables 1 to 4 inclusive, give detailed cost data showing how the summaries given in this article were obtained.

TABLE 4

Comparison of Compression Gasoline Plant Costs

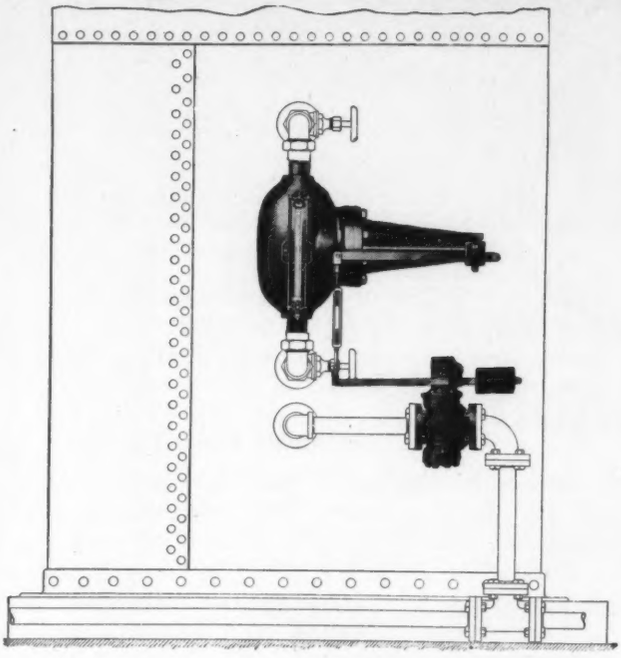
Operating:	Refinery No. 1	Refinery No. 3	Refinery No. 4	Refinery No. 5	Refinery No. 6	Total
Labor	0.0669	6.4265	0.0745	0.2775	0.3409	0.0862
Material	0.0331	0.2576	0.0164	0.0288	0.0114	0.0278
Total	0.1000	6.6841	0.0909	0.3063	0.3523	0.0040
Repairs:						
Labor	0.0364	1.0403	0.0094	0.0330	0.0598	0.0296
Material	0.0294	.4400	0.0134	0.0180	0.0916	0.0260
Total	0.0658	1.4803	0.0228	0.0510	0.1514	0.0556
Fuel Consumed: Gas	....	....	0.0391	....	....	....
Steam, Power and Water	0.2333	5.5422	0.0530	0.2080	0.1849	0.1820
Changing Const.	0.0056	0.4170	0.0022	0.0008	0.0199	0.0050
Retirement Loss	0.0017	....	0.0346	....	....	0.0109
Total Direct Cost	0.4064	14.1236	0.2426	0.5661	0.7085	0.3786
Indirect Plant Exp.	0.0413	6.4525	0.0403	0.2029	0.2783	0.0554
Fixed and Overhead	0.1927	8.9834	0.1826	0.3928	0.6663	0.2123
Total Cost	0.6404	29,5595	0.4655	1.1618	1.6531	0.6463
Production Condensate:						
From Crude Dept.	124,452	117	2,294	2,931	545	130,339
From H. M. V. S. Dept.	72,368	...	7,496	8,691	6,691	95,246
From Producing Dept.	....	....	75,896	....	....	75,896
Total	196,820	117	85,686	11,622	7,266	301,481

T. H. Barton, former vice-president of the Arkansas Natural Gas Company, has been elected president and general manager of the Lion Oil & Refining Company of El Dorado, Arkansas, to succeed E. C. Winters, now chairman of the board.

Mr. Barton took up the duties of his new position January 1, with headquarters in El Dorado; and Mr. Winters, who is still active in the management of the company, will make his headquarters at the general offices in Kansas City.

Both the producing and refining activities of the Lion Oil & Refining Company will be enlarged during the coming year, it was said.

Dependable Liquid Level Control



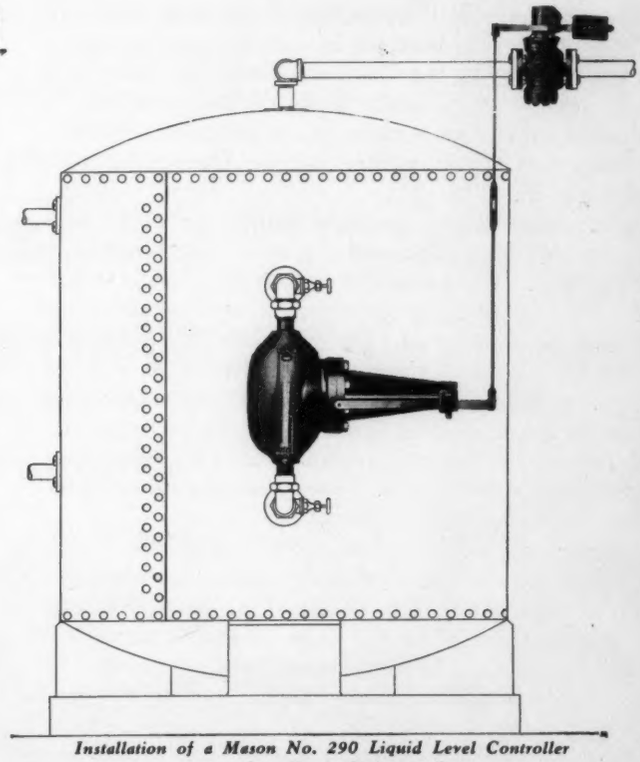
Installation of a Mason No. 290 Liquid Level Controller on an absorber tower.

Where it is inadvisable to place the float inside the liquid container the Mason Liquid Level Controller maintains any predetermined level in stills, receivers, absorber towers, heaters, condensers, closed tanks, etc. It is built to control gasoline, oil, water and other fluids and is often used as a drainer in handling large volumes of condensate from evaporating plants, heaters and condensers requiring a valve of large port area. The leverage of the rotary balanced valve has been considerably increased, making its action more positive, and sticking which was common with the yoke type has been eliminated.

Sturdily built, the Mason No. 290 Controller is unusually sensitive in its action and the slightest change in liquid level causes the float to rise or fall, opening or closing the balanced valve.

Furnished with special trim for corrosive liquids or gases when necessary.

Write for a copy of new Bulletin 290 which gives a complete description of the installation, operation, and maintenance of this Controller, together with prices, weights and roughing in dimensions.



Installation of a Mason No. 290 Liquid Level Controller on a fat oil weathering tank.

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Panhandle Natural Gasoline Plants Being Increased

NATURAL gasoline production in the Texas Panhandle was 12,522,226 gallons in November, 1928. This output came from 36 plants of Hutchinson, Potter, Carson, Gray, Moore and Wheeler Counties.

Hutchinson County has the greater number of plants, 20, and ran first in output, a daily average of 272,231 gallons. Two plants in this county are shut down temporarily.

Eight plants in Carson County, with a gas capacity of 123,000,000 cubic feet, ran 48,615 gallons daily.

Gray County produced an average of 70,745 gallons daily from seven plants. The gas capacity of these plants was 146,000,000 cubic feet. Three plants are building in this county.

Three plants in Wheeler County have a gas capacity of 64,000,000 cubic feet, from which 18,038 gallons of natural gasoline were produced daily.

Potter and Moore Counties have one plant each.

Three new plants were put in operation in November. The gas capacity of the three is 122,000,000 cubic feet. The largest of these is the plant of the Amarillo Oil Company, which has a rated gas capacity of 100,000,000 cubic feet. It is located on the Denver-Amarillo natural gas line.

Three other natural gasoline plants are under construction in the Panhandle. Coltex Corporation is building two new plants under construction in the Lefors field. These will begin operation at well pressure and will have gas capacity of 7,000,000 cubic feet each. The Forrest E. Gilmore Company, northwest of Pampa, which will have gas capacity of 10,000,000 cubic feet, will be on production in January.

Shipments of natural gasoline from the Texas Panhandle reached 904 cars in November, leaving 1,179,655 gallons in storage in the district.

Hutchinson County plants were responsible for 8,160,509 gallons of the Panhandle natural gasoline produced in November. The Phillips Petroleum Company, the leading concern of the area, produces more than 8,000,000 gallons of natural gasoline each month. Of this total, 6,500,000 gallons come from Hutchinson County.

The accompanying tables, which show the status of natural gasoline plant operation, reveal a tendency to enlarge the manufacturing program. In the first table, details of the number of plants, their total gas capacity and the average yield are shown.

NATURAL GASOLINE PLANTS IN THE PANHANDLE AREA AS OF NOV. 1, 1928

County	No. plants	Bldg.	Temp. S. D.	Operating Completed Cu. Ft. Gas	Daily Avg. Prod. Gals.
Carson	8	..	..	123,000,000	48,615
Gray	10	3	..	122,000,000	70,745
Hutchinson	22	..	2	499,000,000	272,231
Wheeler	2	..	..	24,000,000	10,058
Total	42	3	2	768,000,000	401,649

(Plants on domestic gas lines)

					Start oper. after Nov. 1
Moore	1	..	..	100,000,000	....
Potter	1	..	..	30,000,000	3,034
Wheeler	1	..	..	40,000,000	7,980
Total	3	..	..	170,000,000	11,014

Note—Includes Empire's plant on 20-inch line at Wichita, Kansas, and plant on Lone Star's 16-inch line at Hollis, Oklahoma.

Below is the list of the natural gasoline plants of the Panhandle area, giving location, type of plant, gas capacity, gasoline production over a 30-day period and the type of gas being treated:

HUTCHINSON COUNTY

Associated Production Gas Company, (Root et al) SE 19, Blk. Y, two unit, 2500, Southwestern, 6,000,000 cubic feet, temporarily shut down, treating sulphur gas.

Cockrell-McIlroy, SW 14, Blk. Y, two unit, 2500, Southwestern, two 165-horsepower Bessemer engines and compressors, 6,000,000 cubic feet, temporarily shut down, treating sulphur gas.

Dixon Creek Oil Company, NW 11, Blk. Y, absorption, 14, 165-horsepower Bessemer engines and compressors, 20,000,000 cubic feet, 11,965 gallons daily, treating sour, sulphur gas.

Empire Gas & Fuel Company, NE 19, Blk. Y, portable charcoal plant, operating on well pressure, 6,000,000 cubic feet, average daily production 2,129 gallons, treating sour, sulphur gas.

Marland Oil Company, NE 2, Blk. F, oil absorption, seven 165-horsepower Bessemer engines and compressors, 14,000,000 cubic feet, daily average production 2391 gallons, treating sulphur gas.

Pacific American Company, Sec. 26, Blk. Y, well pressure absorption plant, 12,000,000 cubic feet, no report on production, treating sulphur gas.

Phillips Petroleum Company, SE 28, Blk. Y, absorption, 25 165-horsepower Clark compressors, 50,000,000 cubic feet, 30,661 gallons daily average, treating sour gas.

Phillips Petroleum Company, SE 1, Blk. 2, absorption, 12 165-horsepower Clark compressors, 24,000,000 cubic feet, 15,498 gallons daily average, treating sulphur gas.

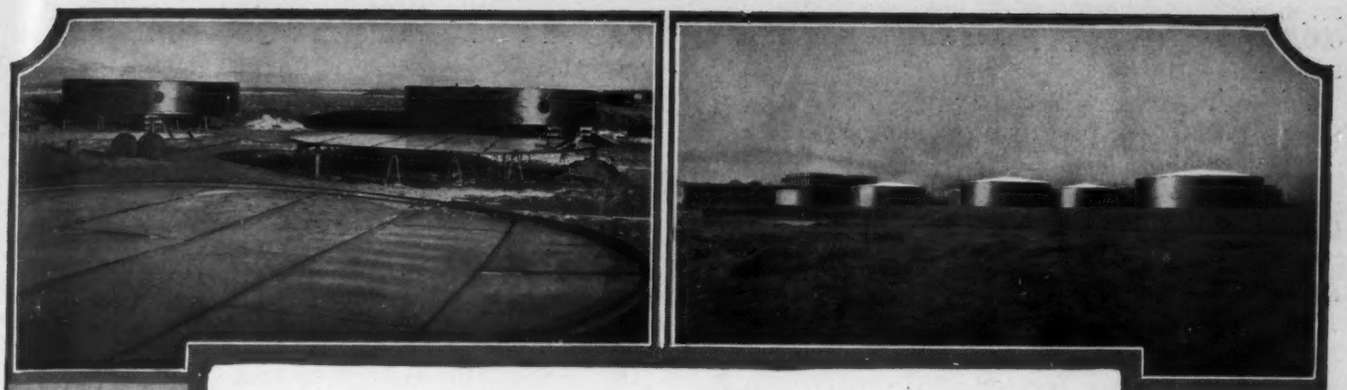
Phillips Petroleum Company, S. 83, Blk. 46, absorption, 10 compressors, 20,000,000 cubic feet, 16,293 gallons daily average, treating sour, sulphur gas.

Phillips Petroleum Company, Sec. 22, Blk. Y, absorption, well pressure, 90,000,000 cubic feet, 43,240 gallons daily average, treating sour gas.

Phillips Petroleum Company, Sec. W, Blk. B3, absorption, 10 400-horsepower Clark compressors, 50,000,000 cubic feet, 35,053 gallons daily average, treating sour gas.

Phillips Petroleum Company, Sec. 69, Blk. 46, absorption, 25 165-horsepower Clark compressors, 50,000,000 cubic feet, 35,599 gallons daily average, treating sour, sulphur gas.

Phillips Petroleum Company, Track 8, M. Whit. ab-



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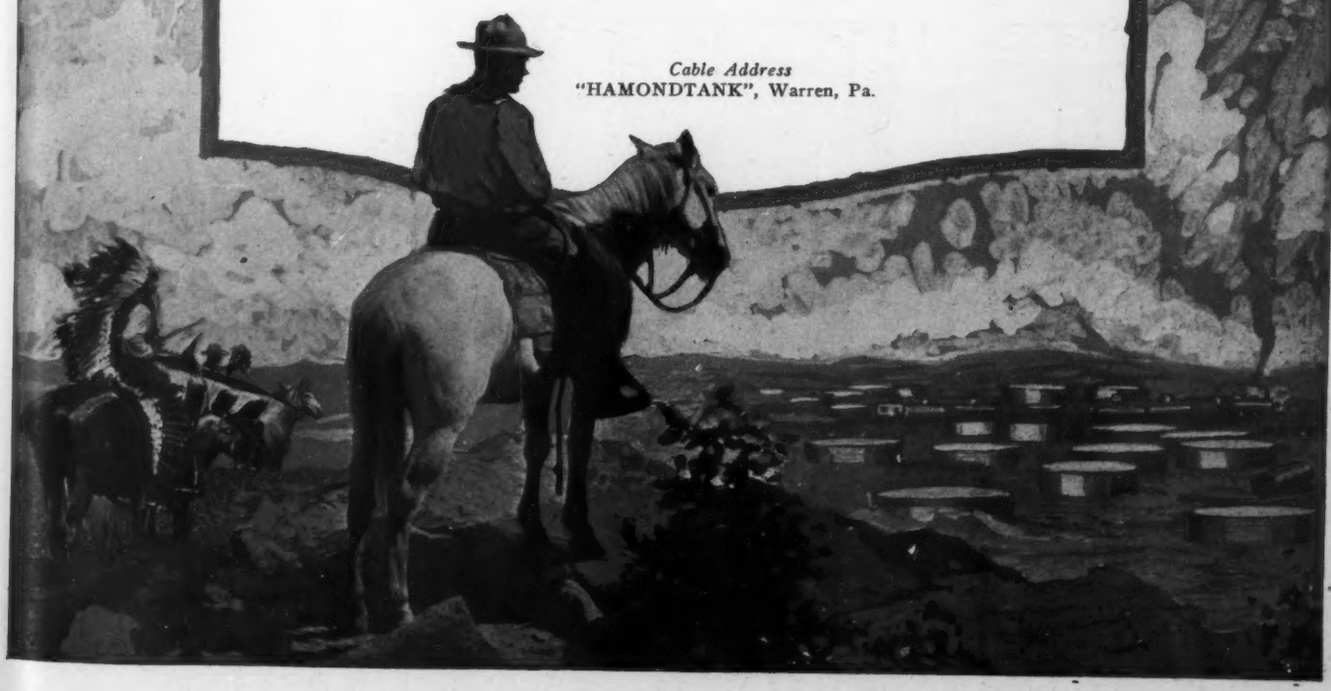

sorption, 25 165-horsepower Clark compressors, 50,000,000 cubic feet, 43,018 gallons daily average, treating sour gas.

Phillips Petroleum Company, SW 5, Blk. Y, absorption, 10,000,000 cubic feet, gas enrichment plant.

Purdue Gas Company, NW 5, Blk. Y, 10,000,000 cubic feet, began operating recently (formerly Union Gas Company plant).

Ralph Baker, NW 10, Blk. Y, 1 unit 75 Southwestern, five, 165-horsepower Bessemer, 10,000,000 cubic feet, 1745 gallons daily average, treating sour gas.

Skelly Oil Company, Sec. 4, Blk. B4, 22 Bessemer and Western engines, Ingersol-Rand compressors, 20,000,000 cubic feet, treating sour, sulphur gas.

Skelly Oil Company, NW 20, Blk. Y, Charcoal plant, three 80-horsepower Bessemer and Ingersol-Rand compressors, 20,000,000 cubic feet, treating sour gas.

Skelly Oil Company, SW 11, Blk. Y, 12,000,000 cubic feet, treating sour gas.

Skelly Oil Company, NE 5, Blk. Y, charcoal plant, five 80-horsepower Bessemer and Ingersol-Rand compressors, 8,000,000 cubic feet, treating sour gas.

Skelly Oil Company, Sec. 6, Blk. Y, absorption, one 165-horsepower and 14 80-horsepower Bessemer engines, eight Ingersol-Rand and seven Worthington compressors, treating sour, sulphur gas. Daily average of all Skelly plants, listed above, is 31,888 gallons.

Sobrie Gasoline Company, Sec. 21, Blk. Y, Southwestern absorption, 8,000,000 cubic feet, 2752 gallons daily average, treating sour gas.

POTTER COUNTY

Cannon Gasoline Company, SW 109, Blk. 2, absorption, Hope type, 30,000,000 cubic feet, 3034 gallons daily average, treating sweet gas.

MOORE COUNTY

Amarillo Oil Company, SE NE 33, Blk. P.M., absorption, three 1000-horsepower Worthington compressors, 100,000,000 cubic feet, began operating after November 1, treating sweet gas.

CARSON COUNTY

Magnolia Petroleum Company, NE 9, Blk. 4, two 2500 Southwestern absorption, 15,000,000 cubic feet, 2261 gallons daily capacity, treating sour sulphur gas.

Marland Oil Company, NE 116, Blk. 5, absorption, two 225-horsepower Miller engines, 8,000,000 cubic feet, 1815 gallons daily average, treating sweet gas.

Phillips Petroleum Company, SW 113, Blk. 4, absorption, 22 60-horsepower Clark engines, 25,000,000 cubic feet, treating sweet gas.

Phillips Petroleum Company, W½ 115, Blk. 5, charcoal type, four 165-horsepower Clark, 10,000,000 cubic feet, treating sweet gas.

Phillips Petroleum Company, S½ 107, Blk. 5, charcoal, 8,000,000 cubic feet, treating sweet gas.

Combined daily average production of the three Phillips plants, 15,699 gallons.

Roxana Petroleum Corporation, SE 107, Blk. 4, one unit 7500 Southwestern, four 225-horsepower Miller Watts engines and compressors, 9,000,000 cubic feet gas, 5739 gallons daily average production, treating sour, sulphur gas.

Skelly Oil Company, SE 88, Blk. 4, three unit Southwestern, 7500, eight 320-horsepower Snow engines, Laidlaw compressors, 40,000,000 cubic feet gas, treating sulphur gas.

Skelly Oil Company, NW 86, Blk. 4, charcoal plant, 8,000,000 cubic feet, treating sour gas.

Daily average of the two Skelly plants 23,101 gallons.

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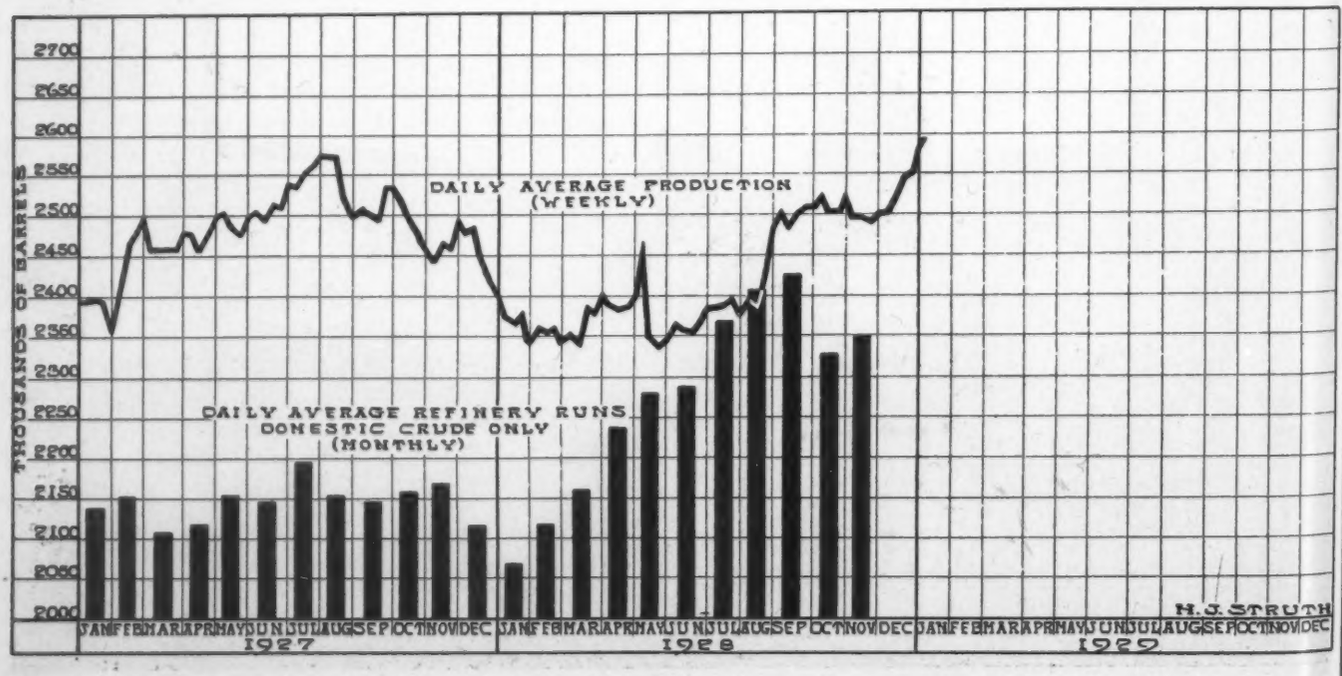

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Boiler Room Chemistry Reduces Steam Troubles

By L. M. WILLIAMS

EQUIPMENT, chiefly from the junk pile, has been used in providing an effective water treating plant for one of the important refineries of North Texas. The labor for building the treater also was provided by the plant force.

As the raw water was high in dissolved solids, mostly sulphates and chlorides, it was decided to use a lime and soda ash treatment.

Four 1600-barrel bolted tanks were moved to the location near the boiler house. A heater was fashioned out of a portion of a discarded steam header and placed on a tower between the tanks. The tower was made of old Dubbs pressure still tubes. The chemical solution tub and mixer was rigged up from parts of a small softener and from materials out of the junk pile. A blow drum for caustic was made of a portion of the steam header, which furnished the shell for the heater. All remaining equipment was used as found, it being necessary only to move it and connect it properly.

Chemicals are mixed in the 200-barrel solution tank, the solution flowing through a half inch pipe at the bottom into a funnel connected to the suction of a small pump. There is a supply of treater water added at the funnel to make up sufficient volume to give velocity to the solution in the delivery pipe and to reduce the tendency of this pipe to clog. A vent connected to the discharge side of the pump is led to the funnel, the valve in this vent being left partly opened to prevent the pump from becoming air bound.

When caustic is used it is cut to a predetermined strength and allowed to flow into the blow drum, where it is forced into the discharge line of the lime and soda pump. Handling the caustic in this manner reduces the upkeep cost on the pump.

Raw water is pumped into the top of the heater and the solution enters the water at a fitting in the top of the heater. In flowing through the heater the temperature of the water is raised from 58 to 205 F. or higher, as shown by the recording thermometer in the bottom of the delivery pipe. Exhaust steam from adjacent parts of the plant passes through the heater downward, giving long contact with the water.

Tank Washing

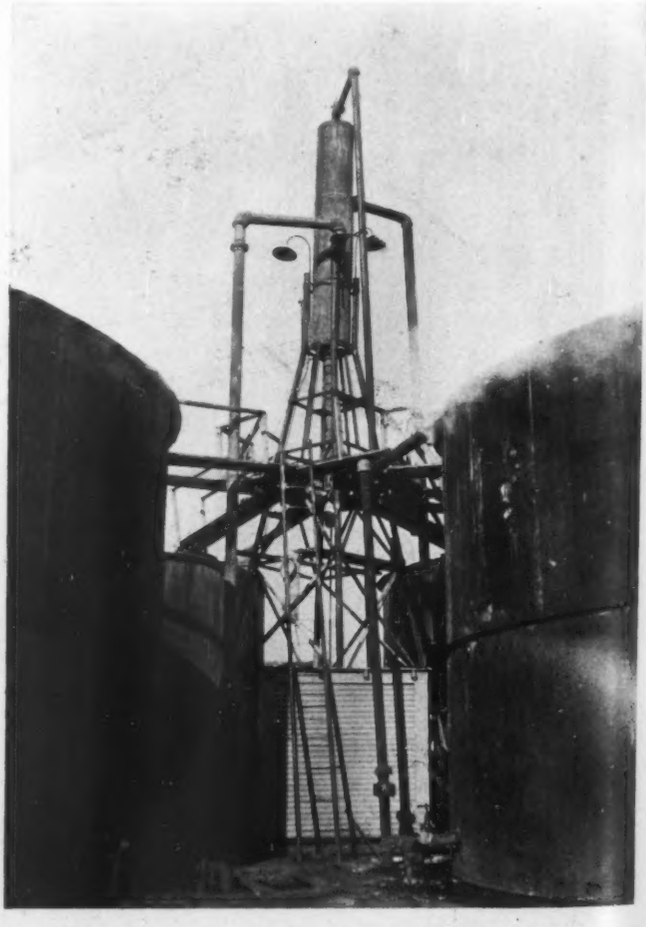
Treated water flows from the heater to one of the four 1600-barrel tanks, where it is permitted to settle until needed. The four tanks allow the emptying of one, the washing and filling of a second, while a third is in reserve and a fourth is settling. Before using water from a tank, the sludge is pumped from around the outlet of the feed pump suction by a small centrifugal pump.

In washing a tank water is fed in near the top through a connection having a 45 degree ell on the inside to give a whirling motion. This is further assisted by agitating with the air. The small centrifugal pump is used to pump sludge away.

From 100,000 gallons to 255,000 gallons of water are treated daily. Other than titrations and soap tests, the treating is done by one man, who gives not more than 10 minutes of each hour from his time in the boiler house.

Equipment necessary for titrations and tests are two 25 c.c. graduation burettes; 1 100 c.c. graduate; 1 200 c.c. Pyrex sample flask; 1 200 c.c. porcelain dish; 1 stirring rod; 1 8-ounce bottle; standard soap solution; methyl-orange and phenolphthalein solution and 1-50 normal sulphuric acid.

The titration procedure is as follows; a 58.3 c.c. sample of the water is placed in the porcelain dish and indicated with several drops of phenalphthalein which gives the water a reddish color, next the 1/50 normal sulphuric acid is added, in one tenth c.c. portions, until the color disappears. The "cc" of acid used is equivalent in grains per to all the caustic alkalinity and one-half the carbonate alkalinity. The same sample is then indicated with methyl-orange, which turns the water yellow, and the acid continued, in like portions as before, until an orange tint appears. The total "cc" of acid used minus that used in the first titration gives the grains per gallon of the remaining half of the carbonate alkalinity, and all the calcium and magnesium



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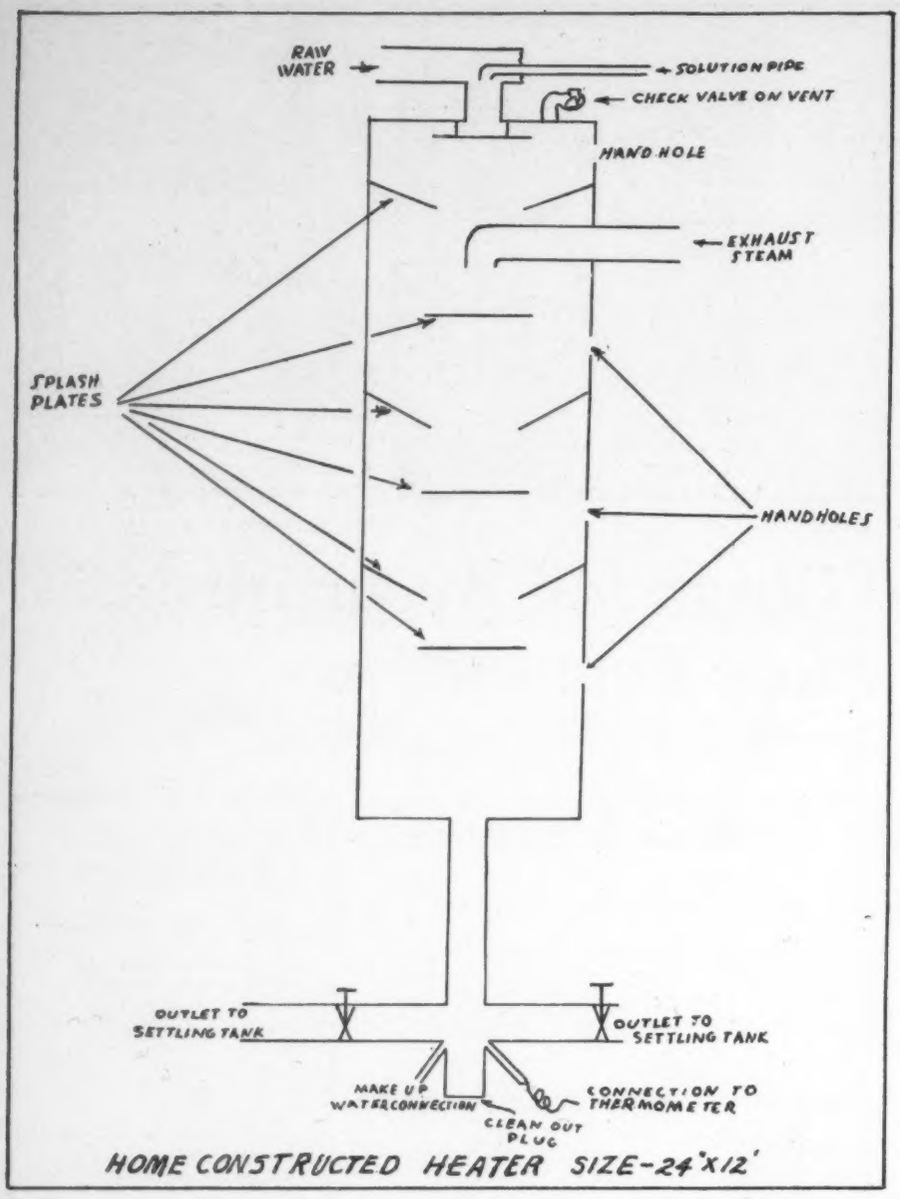


HOME CONSTRUCTED HEATER SIZE-24'X12'

carbonates. Next a sample of the water is placed in a bottle and the soap test made. The amount in "cc" of soap necessary to bring about the permanent lather is noted. The total number of cubic centimeters of acid used in the titrations is deducted from the number of cubic centimeters of soap used and the difference represents the grains per gallon of sulphate hardness.

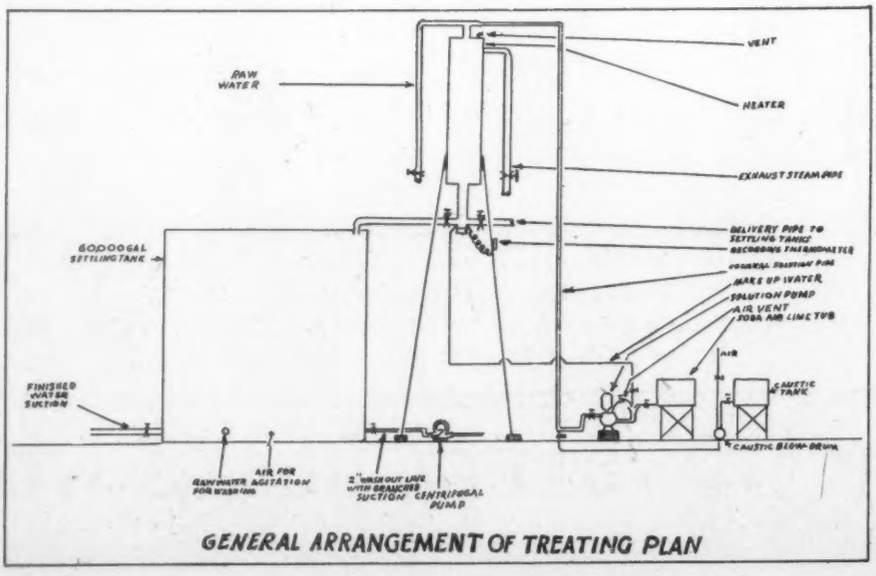
Soap Test

The soap test mentioned, consists of placing a 58.3 c.c. sample of the water in the eight ounce bottle and adding a soap solution, one or less cubic centimeters at a time, shaking the bottle vigorously, between additions, until a so-called permanent lather appears. The lather should stand for five minutes.

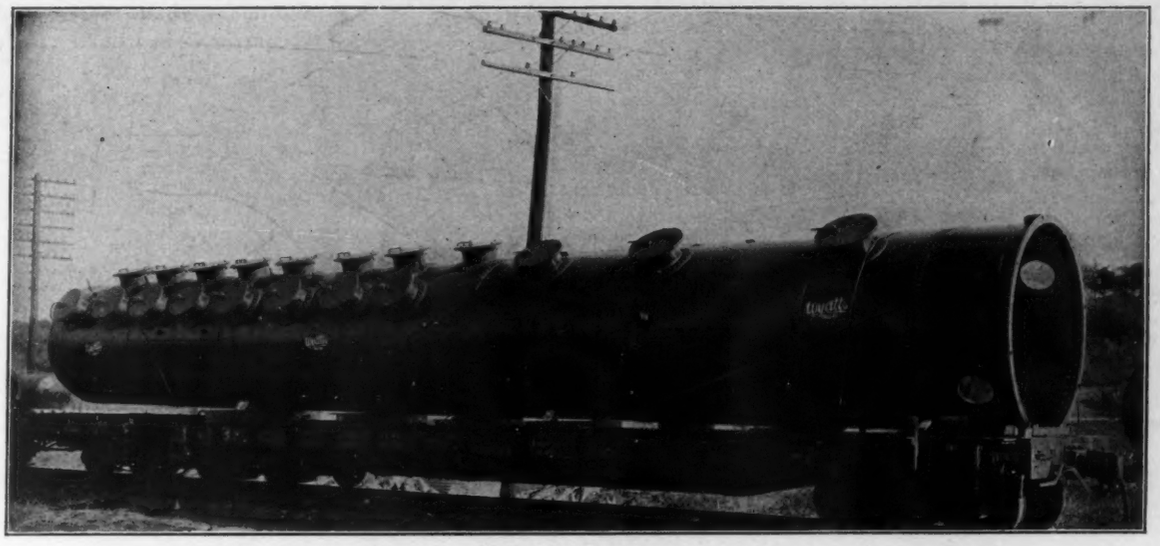
In using standard soap solutions, each "cc" added to a 58.3 c.c. sample of the water represents one grain per gallon hardness in terms of calcium carbonate. In testing both raw and treated water there is the formation of a lather which does not last, and has, quite frequently a faint gray tinge. A further addition of soap is made to bring about a strong white lather, which marks the final end point, the other lather being called the false or ghost point. On laying the bottle on its side and turning it over slowly the first lather, in running down the side does not leave the surface of the bottle clear, but does leave a curdled like deposit, while the last or permanent lather leaves a clean surface. The number of cubic centimeters of the solution necessary to bring about the first lather determines the grains per gallon or magnesium salts, while the difference between that and the total soap used, the hardness as grains per gallon of calcium salts. From the soap solution used, however, is first deducted what is known as the lather factor, this being determined as the amount of soap necessary to form a lather in the same quantity of pure distilled water. This is taken as one cubic centimeter.

Having determined the approximate number of grains per gallon of both carbonate, or temporary, hardness and the sulphate, or permanent, in the water, a nearly correct amount of lime and soda ash to use, is determined by multiplying the grains per gallon of carbonate hardness by 0.09 for the pounds of lime needed per thousand gallons and multiplying the grains per gallon of sulphate hardness by 0.125 to get the pounds of soda ash needed per thousand gallons. These results give a basis to work from. The amounts of chemicals vary considerably, in practice, principally due to variations in temperature attained while treating the water.

After the water is treated and allowed to settle, a sample is taken, permitted to cool and titrated as above. The cubic centimeters of acid needed to bring about the phenolphthalein and methyl-orange end points should not be below



GENERAL ARRANGEMENT OF TREATING PLAN



A Product of the Wyatt Shops—Bubble and Vaporizer Tower 63' in length—8' in diameter

Bubble Towers, Vaporizers and Absorbers are turned out in the Wyatt Shops regularly and satisfactorily for an increasingly large number of Oil Companies and Refineries in the Southwest.

WYATT METAL & BOILER WORKS
DALLAS, TEXAS

Wyatt's **WYATT** **METAL & BOILER WORKS**

0.6 and 1.2 respectively, it being remembered the acid needed for methyl-orange is the total acid used in both titrations. The values obtained for correct treatment from titrations increased, and the ratio between titrations decreased as the maximum temperatures attained in treating decreases. The results obtained from titrations are always to be checked against the soap test. If the phenolphthalein titration is less than half that of the methyl-orange, at 210 degrees treating, or less than two-thirds at 125 degrees more lime is needed, and vice versa, unless, the titration values were too high. Caustic is used when the amount of incrusting solids is high, or when irrigation water is being treated, the amount being governed by the lowest of the groups of incrusting solids, placing the bicarbonates in one group, and the sulphates in another. This is necessary as the caustic reacts on both, in the course of which reactions the functions of both lime and soda ash are preformed.

Examples of Treating

If more caustic is provided than necessary for the smaller of the two groups, the titrations show an overtreat as of the lime or soda ash needed for the smaller group. The net cost is slightly higher than when lime and soda ash alone are used, but this is offset by the handling of a smaller bulk, and the decreased difficulty in obtaining a thorough mixture of the chemicals with the water. Raw water having the following major scale forming matters:

	Grains per gallon
Calcium bicarbonate	.84
Calcium sulphate	22.27
Magnesium bicarbonate	13.27
Total	36.38

Was treated to

Calcium sulphate	.36
Magnesium bicarbonate	.64
Total	1.00

the same apparatus on water having the following:

Calcium bicarbonate	12.27
Calcium sulphate	3.35
Magnesium bicarbonate	9.94
Total	25.46

delivered water having

Calcium bicarbonate	1.49
Calcium sulphate	0.17
Magnesium bicarbonate	.20
Total	1.86

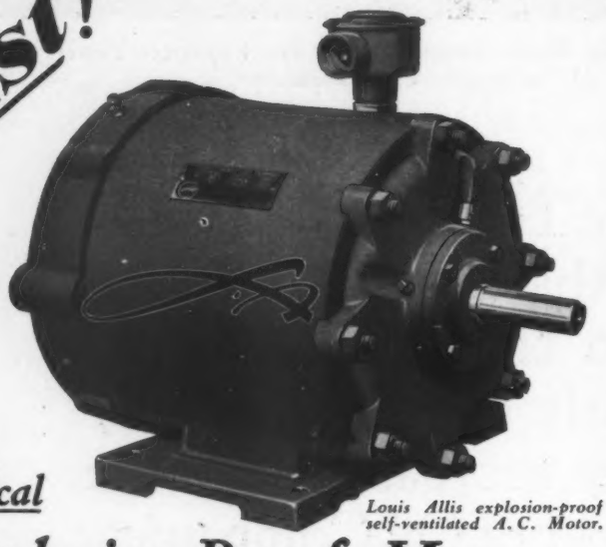
The above are taken from evaporation analyses. The chemical cost in the first instance was around 7.1 cents per thousand gallons recovered lime, soda ash, and caustic being used. Lime and soda ash were used in the second, the cost for chemicals being 3.05 cents per thousand gallons recovered. In each instance there is a slight excess of soda ash which was desirable.

Before installing this apparatus the plant had more than 2,200 rated horsepower in capacity under the fire and one boiler always being cleaned. At present it has 1,050 rated horsepower under fire for the same plant throughput and keeping boilers in service from five to eight months, taking them off for washing and inspection only. The fuel consumption has been cut from around 440 barrels daily, to 195 barrels and maintenance charges all but eliminated. The water treating chemical costs were reduced to a greater extent, this charge now being around $225 per month. The boiler-room operating labor, or firemen's wages, was reduced $810 a month.

A. H. Green has been appointed district manager for Oakite Products, Incorporated, in Tulsa. Mr. Green's office is located at Tulsa Storage & Transfer Company, and a stock of Oakite materials is maintained there. A. J. Ospring is no longer connected with Oakite Products, Incorporated.

The Norwalk Company has just placed an order for two seven-foot Campbell "Oil-Froth" absorbers to be installed at Santa Fe Springs, one in its old plant and one in a new one, completed by the J. A. Campbell Company, November 17. With this additional large-capacity absorber installed, the new plant will be capable of handling gas in excess of fifty million cubic feet per day.

At Last!



Louis Allis explosion-proof self-ventilated A. C. Motor.

a practical

Explosion-Proof Motor for Refinery Service

Tested and Listed by Underwriters' Laboratories . . . For use wherever gasoline is made, used, or handled . . . The only approved explosion proof motor of self ventilated type . . . Weight is only half that of non ventilated motor—and but slightly greater than ordinary open motor . . . Can be installed in practically same space as open motor . . . It is suitable, therefore, for mounting direct on pumps, etc. . . . It brings to refineries for the first time the economy and convenience of a small, safe, direct motor drive—without use of fire walls . . . Permitted under National Electrical Code.

Practical—Safe—Economical

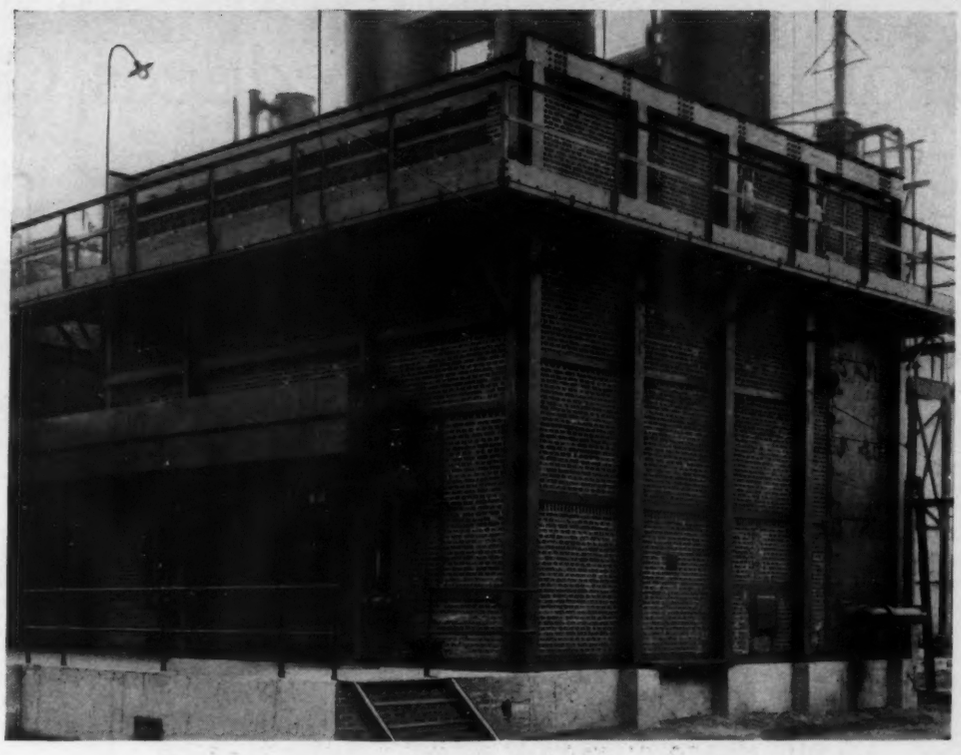
Standardize on this Louis Allis motor for your plant. Specify it on machines that you buy.

Sizes 1 to 15 H.P. available now, 1 to 30 H.P. in near future.

Write for descriptive pamphlet.

THE LOUIS ALLIS CO.

Motor specialists for 27 years Milwaukee, Wis. *Offices in principal cities*



A 14,000 Barrel Foster Tube Still

The Foster tube still shown in the above photograph has the capacity of heating 14,000 barrels of crude daily to a temperature of 500 deg. F. and provides for 37 per cent evaporation.

The furnace roof in this still consists of 5-inch bare tubes. These are arranged two rows high and in staggered position so that the entire area presents a radiant heat absorbing surface.

The two top rows of heating tubes in the main heating bank are covered with iron castings of the corrugated type, giving a moderately extended heat absorbing surface. The next four rows are covered with cast iron gilled rings 6⅝″ in diameter while the bottom eight rows of tubes are covered with cast iron gilled rings 7⅝″ in diameter.

The construction thus provides an increasing heat absorbing surface per lineal foot of tube as the temperature of the gases falls off and the volume of gases decreases. Large inspection doors are provided opposite the return headers of each tube, so that all plugs and tubes are readily accessible from outside while the unit is in operation.

FOSTER WHEELER CORPORATION

165 Broadway, New York, N. Y.

Branches in Principal Oil Centers

Foreign Associates:—
Foster Wheeler Limited, London, England.
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FOSTER WHEELER

FRACTIONATING TOWERS HEAT EXCHANGERS
STEAM JET AIR PUMPS SUPERHEATERS
TUBE STILLS VACUUM PUMPS
WATER COOLED FURNACE SURFACES
BRASS AND COPPER TUBING AND PIPE

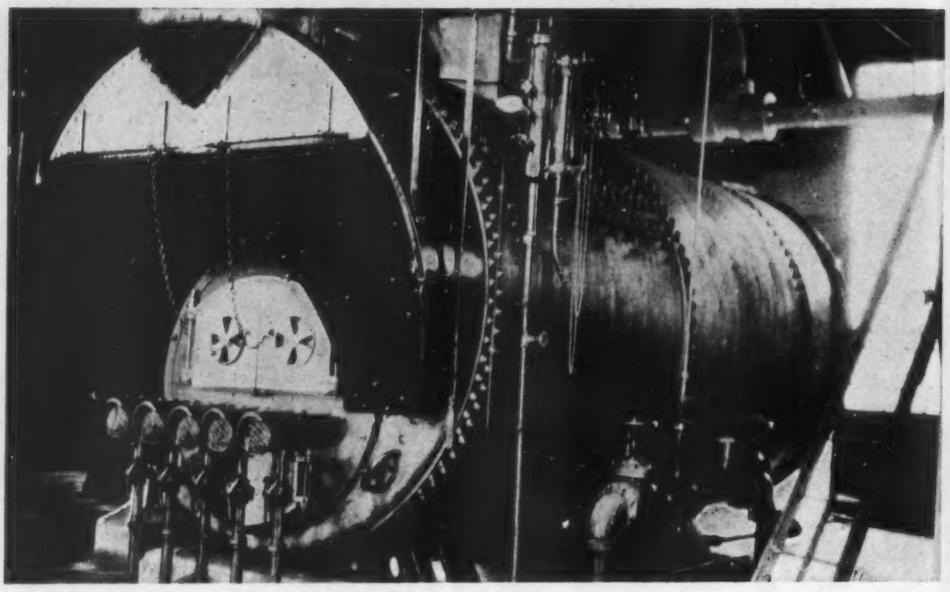
AERO UNIT COAL PULVERIZERS
AIR HEATERS CENTRIFUGAL PUMPS
CONDENSERS COOLING TOWERS
ECONOMIZERS EVAPORATORS
EXPANSION JOINTS FEED WATER HEATERS

Mention Where You Saw the Advertisement

Control Equipment Reduces Costs In Power Plant

IN all boiler plant installations, whether one boiler or a dozen, the features of dependable automatic control of firing, water supply, and steam produced are always given much consideration.

Reliable control instruments greatly reduce the usual hazards and dangers of power plant operation, and are conducive to the practical elimination of the employment of labor for boiler watching only. The installation of reliable equipment for positive control of furnace temperatures, steam pressures, and water supply, does much toward eliminating the risk concurrent with steam generation. Such control can be so inclusive of all details of operation that the boilerman, as such, can be dispensed with entirely and such occasional inspection as the power plant would require can be given it by those employees active about the plant in the other departments.



Details of installation of fuel gas regulator and feed water controller, on one boiler of the battery at ColTex Gasoline Company's Fairbanks, Louisiana, natural gasoline plant

Such devices designed for positive control of the power house operations are becoming more and more popular and more extensively employed by manufacturers of natural gasoline, as well as refiners.

At the Fairbanks, La., natural gasoline plant of the ColTex Gasoline Company, (Columbian Gasoline Corporation) the operators have effected a reduction of labor overhead through the installation of modern control equipment in the power plants and at the same time have secured smoother operation of the steam generating equipment, with a lowered cost for fuel as well as labor.

Even, controlled, firing is secured through the installation and operation of regulators on the incoming gas line leading to the burners. A Chaplin Fulton regulator at the boiler, controls the even flow of gas to the furnaces. Other regulators located in the plant yard control the gas flow, the first one reducing pressure from 300 pounds to 100 pounds. Two other regulators effect a reduction from 100 pounds to 11 pounds, and from 11 pounds to 10 ounces.

Steam is conducted to this regulator from the steam head, or steam manifold at the top of the boilers through small lines. The boilers are operated at 125 pounds pressure and any decrease in steam pressure due to taking on fresh water, ect. causes the gas regulator to open, admitting more gas to the burners and thus increasing the fire. Any increase in steam pressure on the boilers acts in the opposite manner causing the regulator to cut down the volume of gas flowing to the burners. The boilers are also equipped with the usual pop-off or relief valve, to relieve them of any suddenly built up heads of steam. One fuel regulator controls the fires under all of the boilers.

Pump house and electricity generating plant at ColTex Gasoline Company's Fairbanks, Louisiana, plant. Pump operation is controlled by regulator working off steam header line

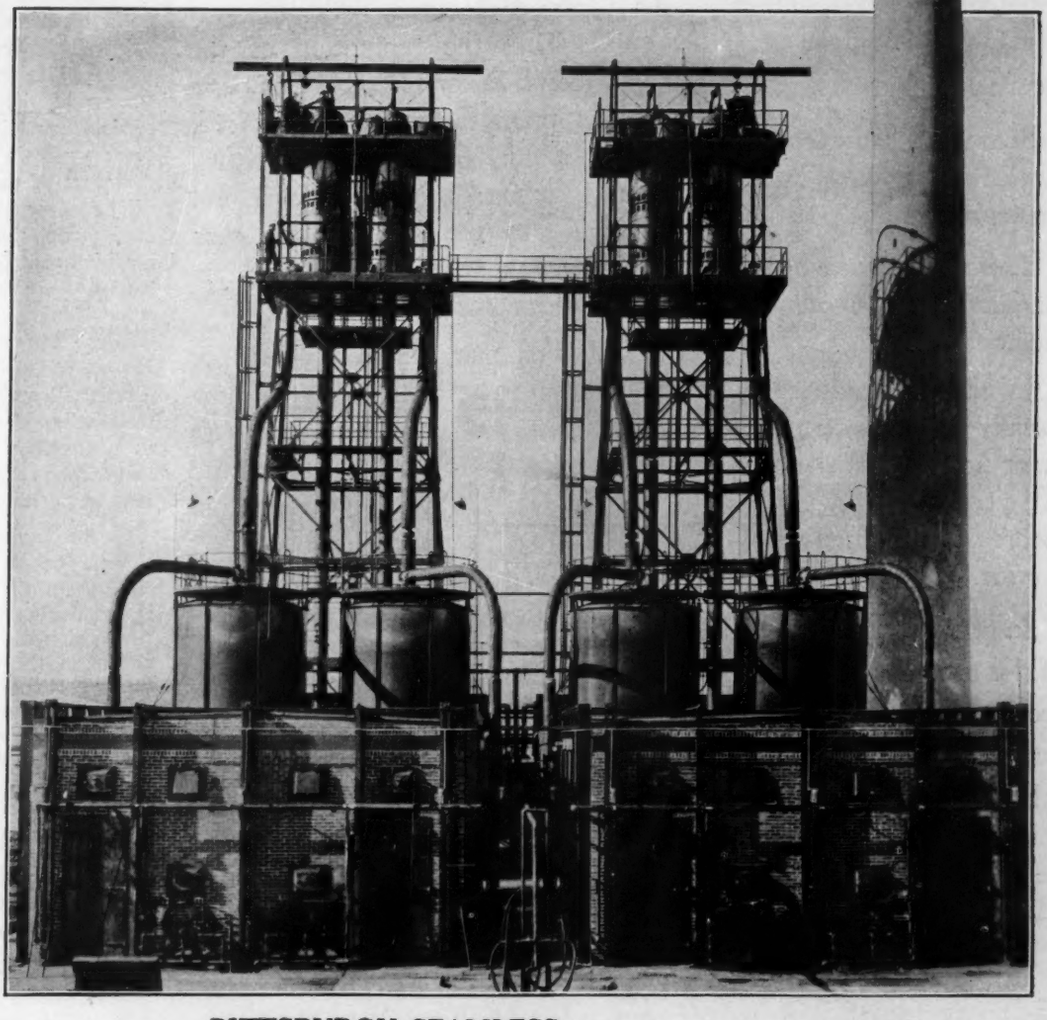
Individual water regulators are installed on each boiler. This plant uses Kitts Safety Feed Water regulators, controlling the water level in the boilers and the operation of the boiler feed water pumps. One instrument at the gauge glass on the boiler controls the water level in the boiler, through the opening and closing of a small needle valve. When water level lowers the valve opens and steam pressure acting upon a regulator at the side of the boiler causes this regulator to open the water in-take line slightly, admitting more water to the boiler. The reverse action takes place when sufficient water is taken

"Why Use Pittsburgh Seamless Steel Tubing For Hard Service?"

This is for the fact-finding refining man who accepts or rejects pipe and tubing on the strength of his own good judgment:

PITTSBURGH Seamless steel tubes are high-pressure tested. Their uniform, elastic, forge-textured steel is flawless. They have no seams—no potential trouble-spots—no pinholes. They expand as a unit—contract as a unit. Their walls are thick and smooth—unresistant to liquid flow—which minimizes the scale nuisance. They are ***strong.***

In boilers they stand fire, steam pressure and hot water with equal calm. In condensers they absorb inside heat and outside cold, unaffected by either. In still service they withstand repeated fractionation processes with the shirt-sleeved dignity of a proud service record to uphold.



PITTSBURGH SEAMLESS

Still Tubes ***Boiler Tubes*** ***Condenser Tubes*** ***Refinery Piping***

Steam Lines ***Oil and Gas Pipe Lines*** ***Tank Car Piping***

Coils ***Heating Systems*** ***High Pressure Piping***

Pittsburgh Steel Products Co.

DIVISION OF

Pittsburgh Steel Co.

PITTSBURGH NEW YORK DETROIT CHICAGO HOUSTON TULSA

Mention Where You Saw the Advertisement

Know your paint!

The importance of protecting metal surfaces against rust and corrosion is generally recognized. There are prevalent, however, many different ideas about protective paints and their respective merits.

The intelligent selection of a protective paint must always be based on three fundamentals:

First, a knowledge of the pigment and vehicle used.

Second, a knowledge of the service records made by the paint for representative satisfied users.

Third, a knowledge of the manufacturer's reputation and facilities.

With this knowledge, it is usually easy to determine whether or not a particular paint will meet the requirements of a specified service.

In future issues of this magazine we will show the importance of the physical properties of protective paint pigments, and especially the difference in graphite pigments.

That the reputation of the Joseph Dixon Crucible Company is unimpeachable is evidenced, not only by our many satisfied customers the world over but also by the fact that the year 1927 marked our One Hundredth Anniversary.

For one hundred years our business has followed every ramification of graphite use. With every known grade and form passing through our hands, we are in a position to select and use that kind of graphite best suited to any particular purpose.

Write for Color Card and Booklet No. 99

The labor cost for painting averages 1½ cents a square foot (about twice the cost of the paint applied). This labor cost is the same whether a cheap paint or a good paint is used. When you specify good paint that lasts twice as long in service, the labor cost is halved at a fractional increase in the small paint cost.

Joseph Dixon Crucible Co.
Jersey City *Established 1827* New Jersey

DIXON'S SILICA GRAPHITE PAINT
Adequate Protection at Minimum Ultimate Cost

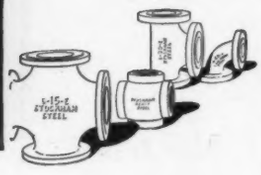
in. Each boiler is so equipped. This type of regulation would indicate that the water pumps would necessarily be running under a full head of steam and bucking pressure at all times. This, however, is avoided by employing control regulators of the same type at the water pumps.

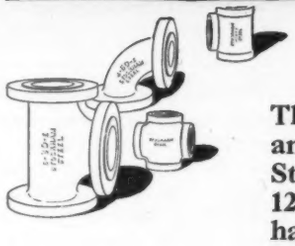
These regulators are of the diaphragm type operating under direct steam pressure from the steam header line on the top side of the diaphragm, with direct water pressure to the lower side. When water goes down steam pressure increases and the increase in steam pressure overcomes the resistence of the water pressure so that the diaphragm is forced down, admitting more steam and causing the pump to speed up to discharge more water to the boiler. The reverse of the procedure takes place when the water level rises to the desired height. When water increases and the steam pressure is reduced, slowing the pump down, the desired equilibrium is reached in a very few strokes of the pump. With this system of dual control of water to the boilers a greater margin of safety is attained. In the event of the failure of either control of the water flow, at the boiler or at the feed pump, the service of accurate and sensitive control will not be seriously impaired, since the pump control, or the water level control regulator at the boiler is adequate for periods of short duration. However, no difficulty has been experienced with either of the regulators, and their independent, yet simultaneous, action in controlling the water to the boilers assures the required evenness and smoothness of operation.

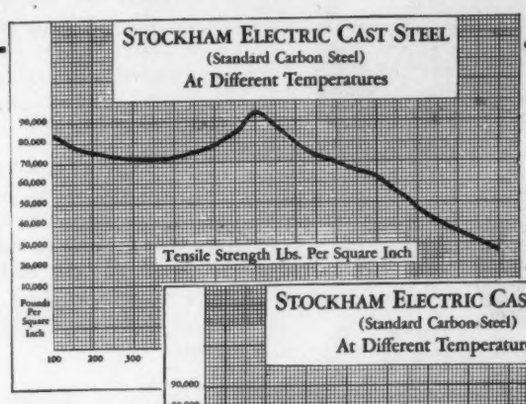
In the accompanying illustration some of the details of this installation are shown. In the pump house, the Worthington duplex, 6 x 4 x 6 inch water pumps, equipped with the Kitts regulators are shown in the background. In the foreground o fthe same photo is the compact electric generating units which furnish lights for the plant and the company's field houses located nearby. The plant consists of Westinghouse steam turbines driving generators of the same make, direct current, 25 KW; 125 watts and 200 bolts. The units are very compact and require little attention, and are operated alternately.

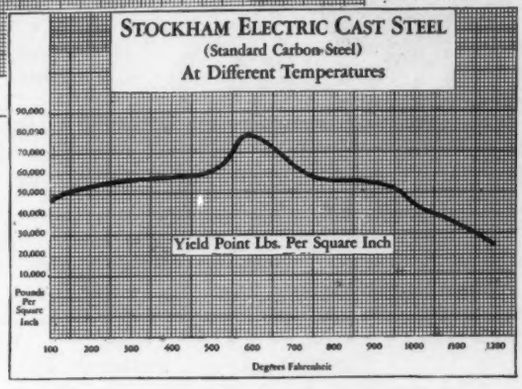
The Connersville Blower Company, Connersville, Indiana, has out Bulletin 4-D, which gives a brief history of the development of the double impeller type of blower or pump and of the rotary displacement meter. It carries a description of the method of measurement, illustrations of Connersville features and design, including bearing mounting, rectangular inlet box, the standard register and the P. V. T. T. Recorder. This bulletin also describes the Connersville Tandem Meter and the Connersville Demand Meter, the latter recording the maximum consumption on an hourly or a 30-minute interval.

Steel Fittings of Consistent Strength *produced with Stockham Accuracy*









A. S. T. M. Minimum Requirements A 95-28 T

Tensile Strength 70,000 lbs.

Yield Point 36,000 lbs.

The charts above show the average tensile or ultimate strength and the yield point or elastic limit of many tests of Stockham Steel giving its behavior under temperatures between 100° and 1200° F. These charts show the consistent high strength of Stockham Steel, well above the A. S. T. M. minimum requirements, giving a wide margin of safety in high temperature or high-pressure pipe lines.

Every Stockham Steel Fitting is hydrostatically tested, with hot water at 212° F., to 2½ times its rated steam working pressure. Thus all fittings are certain to be absolutely sound before shipment. Made according to the American Standards in Series 15, 30, 40, 60, 90 and 135, in standard carbon steel; special alloy steel furnished upon specifications.

Buy Stockham Fittings from leading supply houses. Full stocks carried in Oklahoma and Texas by E. L. Wilson Hardware Company, International Supply Co., Midwest Piping and Supply Co.; in California by The Republic Supply Co., Petroleum Equipment Co., and Midwest Piping and Supply Co.

STOCKHAM PIPE & FITTINGS CO., *Birmingham, Ala.*

Stocks in Boston, New York, Chicago, Tulsa, Los Angeles

Be sure the name **STOCKHAM** *is on the Fittings you buy*

STOCKHAM FITTINGS

CAST IRON — ***Screwed—Flanged—Drainage***

ELECTRIC CAST STEEL — ***Screwed—Flanged***

MALLEABLE — ***Standard—Extra Heavy—Oil Country Malleable***

Mention Where You Saw the Advertisement

To Prevent a Vacuum

The *Fulton Duplex Sensitive Vacuum (or Back Pressure) Regulator* is designed for use on a system discharging gases to a line under light vacuum, where it is desired to maintain atmospheric pressure.

This regulator acts as a safeguard when used on the vapor lines connected to storage tanks and prevents the pulling of a vacuum when adjusted as a vacuum regulator.

The same regulator may be adjusted to act as a *Duplex Back Pressure Regulator* and will control a slight pressure above atmosphere with the same accuracy as when used to control a light vacuum.

Send for catalog.

CHAPLIN-FULTON MFG. COMPANY
28-40 Penn Ave., Pittsburgh, Pa.

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A NEW AND EXCLUSIVE PROCESS

We are pleased to announce to the trade that we are distributors for
TUBE TURNS, Inc.
LOGAN ST. AND GOSS AVE.
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No thinning of outside wall or buckling of inside wall. Greater strength, less friction, longer life.

Wide Applications

Used to provide any kind of elbow, off-set, branch, or return bend in welded piping. To replace cast fittings and mitre-welded elbows, or wherever a tight, flexible, safe, SEAMLESS drawn fitting of low friction resistance will improve the installation.

Immediate delivery of standard sizes from either our own warehouse, or from stocks at Louisville, Ky. Price lists and descriptive bulletins mailed on request.

Maintenance Engineering Corporation
1400 Conti St. Phone Preston 2274-5
Houston, Texas

SAN ANTONIO PLANT SOLD

Indiana Oil & Gas Company, a subsidiary of American-Controlled Oil Fields, Inc., purchased Grayburg Oil Company of San Antonio, properties of the latter being reported to be valued at near $8,000,000. Grayburg Oil Company has been operating as a producing, refining and marketing concern for about 15 years in South Texas.

The deal was negotiated between F. L. Thompson, president of Grayburg Oil Company, and Arthur J. Devlin, president of American-Controlled Oil Field, Inc., and S. M. Newton of New York, president of the Indiana Oil & Gas Company.

Grayburg Oil Company was organized as a producing company and started operations in the Somerset field of Bexar and Atascosa Counties. Later it built a refinery in San Antonio which has been expanded to a 4000-barrel daily capacity plant. The company owned an 18-mile pipe line from Somerset to the refinery and a 65-mile line from the refinery to the Luling field in Caldwell County. In addition to owning about one-third of the production of the Somerset field, Grayburg Oil Company owned production in Luling, Mirando, and Yates pools and held some wildcat acreage.

Following initiation of refinery operation, Grayburg Oil Company developed a chain of retail stations in South and Central Texas, including the cities of San Antonio and Austin.

INSTALL JENKINS UNITS

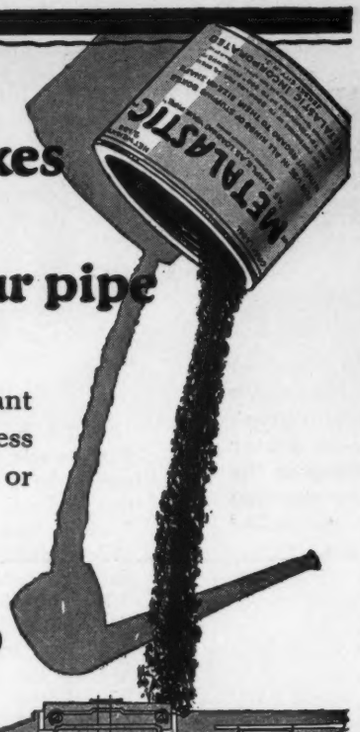
Graver Corporation, of East Chicago, has completed installation of three Jenkins cracking units in three remotely separated refineries, and operation of the units has been started. The units are at the plants of the Tri-State Refining Company, Kenova, West Virginia; Western Oil Corporation, Duncan, Oklahoma; and Motor Fuel Products Company, Laredo, Texas. Each refinery has one unit with a capacity of 1200 barrels daily. They are designed to operate with either fuel oil or gas oil. None of these refineries previously had cracking equipment.

Contracts have been obtained by Graver Corporation also for installation of one Jenkins unit each in the plants of the Orient Petroleum Company, Wichita Falls, Texas, and the Noble Oil & Gas Company at Burkburnett, Texas, both of which have heretofore been operated as skimming plants. Graver Corporation has also contracted for the construction of two additional units at the Big Spring, Texas, refinery of Cosden & Company, now under construction; four units having previously been contracted for.

Allen Oil Company has moved its offices from Lovell, Wyoming, to Great Falls, Montana. The company's refinery at Lovell, which has been shut down for several years, is expected to be put in operation soon.

Pure Oil Company is building a second unit of Gyro vapor phase cracking equipment in its Heath, Ohio, refinery; the first was put in operation some time ago.

Packing Stuffing Boxes as easy as loading your pipe



Serves in any plant equipment, regardless of service, pressure or temperature.

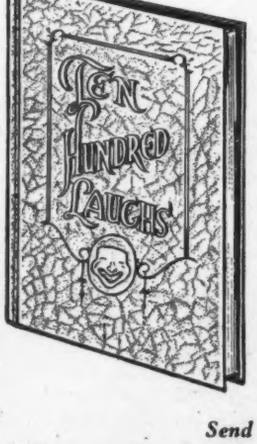
METALASTIC INCORPORATED
Jersey City, N. J.

METALASTIC
For *All* Stuffing Box Requirements!

Just off the press

TEN HUNDRED LAUGHS

By JUDGE RAY SCRUGGS



Contains a comprehensive collection of choice anecdotes and stories, compiled by Judge Scruggs after many months of research. A veritable encyclopedia of fun and humor. Contains a number of darkey stories and stories of the South.

Bound in Castillian cover; thoroughly classified and indexed. Postpaid, $2.00.

Send check to

THE GULF PUBLISHING COMPANY
P. O. Box 1307 Houston, Texas

Certainty of Operation

CONTINUOUS 24-hour operation puts a premium upon certainty of operation. For this reason, the large oil company in whose plant this photograph was taken has selected De Laval Pumping Equipment, and two of the pumps shown may be driven by either an electric motor or a De Laval velocity stage turbine. One has a capacity of 5,000 gallons per minute against 173 ft., at 1200 r.p.m., and the other 1800 gallons per minute against 290 ft. head, at 1800 r.p.m. In addition, there are three motor driven pumps, one having a capacity of 1800 gallons per min. against 290 ft. head at 1800 r.p.m., and the other two delivering each 5000 gallons per min. against 173 ft. head at 1200 r.p.m.

De Laval Pumps are built to limit gauges on an interchangeable basis throughout, and all parts can be replaced by unskilled men, as new parts ordered from the factory do not require to be fitted. Efficiency, head delivery, and other characteristics are guaranteed and are verified by tests at the Works before shipment.

Ask for Catalog C-116

De Laval
Steam Turbine Company
Trenton, New Jersey

Local Offices: Atlanta, Boston, Charlotte, Chicago, Cleveland, Duluth, Havana, Helena, Honolulu, Houston, Kansas City, Los Angeles, Montreal, New Orleans, New York, Philadelphia, Pittsburgh, Portland, Ore., St. Paul, Salt Lake City, San Francisco, Seattle, Spokane, Toronto, Vancouver.
728

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OKLAHOMA CITY CRUDE

The oil which has been produced by the "Oklahoma City" well of the Indian Territory Illuminating Oil Company has been tested and it is concluded that it will be of excellent quality from a refining standpoint, although containing a lower gasoline yield than the average Mid-Continent crude. Following are the tests on a sample of the crude:

Gravity—37.0 A. P. I.
Sulphur—trace.
Color—very light green.
Cold test—Below 20° F.
Pet. yield of U. S. motor gasoline 31-32%.

The well is located six miles southeast of Oklahoma City. Initial production was 5000 barrels from 6360 feet and the well was ordered drilled deeper in the belief that production was from the Simpson or Hunton lime, and desiring to test the Wilcox sand, where the life of the production would be longer if found there.

Based on laboratory investigations, and the light color of the crude and good quality of residuum after topping, the opinion has been expressed that the oil will furnish a good grade of steam refined stock; and there is a heavy wax distillate which indicates a high wax yield.

McColl Frontenac Refineries, Inc., will build two 1000-barrel Gyro process vapor phase cracking units in its plant at Toronto, Canada. The company has a similar installation in its Montreal refinery.

Paragon Refining Company, which recently took over 100 service and two bulk stations in Detroit, will establish marine facilities, and is now planning construction of the necessary tanks, barges, dock improvements and other equipment.

Standard Oil Company of California's natural gasoline division has developed a liquefied petroleum gas called "Readygas," which is being used both as domestic fuel and in the fields without pipe line facilities.

In view of increased gas supply in the vicinity, the General Petroleum Corporation of California has increased the capacity of its Santa Fe Springs natural gasoline plant from 25,000 to 60,000 gallons daily.

This company has seven gasoline plants, which, with the increase at Santa Fe Springs, will have a combined daily output of 215,000 gallons. These plants include the following: two at Long Beach, a 15,000-gallon and a 25,000-gallon plant; a 50,000-gallon plant at Ventura; a 10,000-gallon plant near Los Angeles; a second plant at Los Angeles, a 40,000-gallon compression type; and a 15,000-gallon plant at Placentia.

L. H. Medus died at Port Arthur, Texas, December 14, as the result of being sprayed with heavy, boiling oil along with several other employees, when opening the manhole of a fractionating tower of The Texas Company refinery. Two other men were seriously burned, and eight were slightly burned in the same accident.

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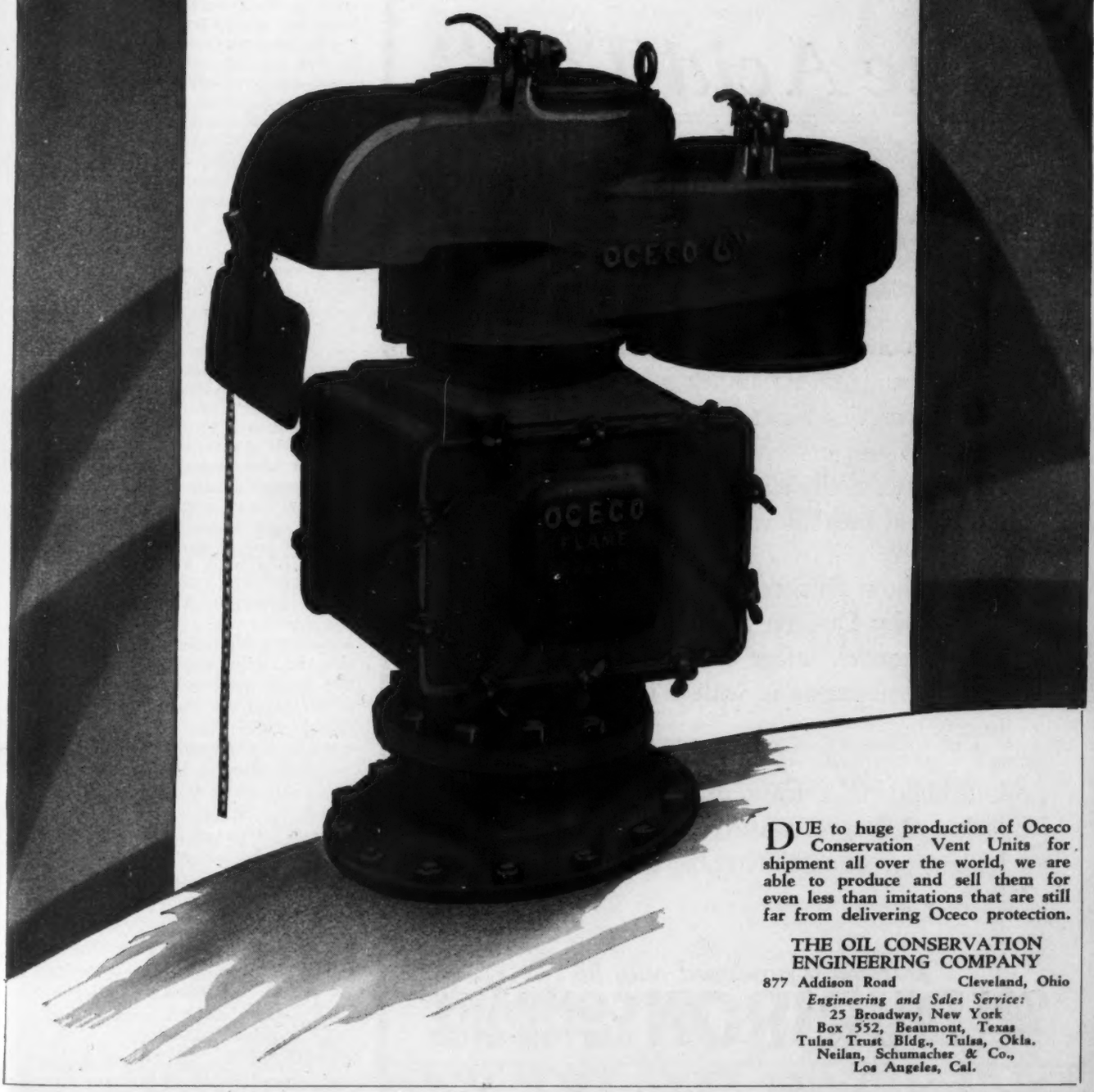

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ABSTRACTS OF TECHNICAL LITERATURE

Of Particular Interest to the Plant Operator

By H. L. KAUFFMAN

The Petroleum Industry in 1927. *Kissling.* (*Erdol u Teer, Sept* 5, 1928, *p.* 440. *Libr. Bull., U. O. P. Co., Vol.* 5, *No.* 39.) *Dehydration of Petroleum.* Among the dehydrating and de-emulsifying agencies, the use of which was patented during 1927, may be mentioned waste acid sludge from gasoline refining. Halloran (U. S. Pat. 1,597,461); a condensation product from a sulfonated polycyclic aromatic compound and a soap-forming radical, by De Groote and Adams (U. S. Pat. 1,641,804); aromatic or aliphatic sulfonic acid salts by Coggeshall and Reilly (U. S. Pat. 1,643,698); derivatives of sulfonated or sulfurized fatty acids, by Bloxam (Brit. Pat. 225,617); cotton, iron and monel metal by Gates of the Standard Oil Company (of Calif.), U. S. Pat. 1,573,389. Centrifuging, heating devices, and especially the electrical discharge were prominent in the inventions. Kuczinski discusses the electrical behavior of natural petroleum emulsions.

(a) *Distillation.*—With the least possible cracking of hydrocarbons. Jackson and Lewite report upon the advances made in this field. Cibulka and Parish upon vacuum distillation; Tschernoshukow and Gavin and Foster upon distillation in a current of gas; Stratford on building a centrifugal pump in the still for keeping the oil in motion; Kroch upon the advantages of the Moscicki distillation process from the standpoint of heat technique; Poole, upon the working up of the high-sulphur Mexican oils; Donath upon the desulfurizing of still gases rich in sulfur by conducting them over pyrolusite. Woloch, Emmuil, and Lewenstam, Clark and Howard, and Tregulow describe new fractionating processes and apparatus. Burrell states the requirements placed upon fractionating columns.

(b) *Distillation with cracking.*—The Werschen-Weissenfelser Braunkohlen A.-G. patented a device by which only the vapors, not the liquid, are brought in contact with the catalyzing surface (Ger. Pat. 439,010); Blumner took out a patent upon the avoidance of coke separation by adding coal-tar oil (Ger. Pat. 437,613); Cuddy, upon an apparatus for either two-phase or continuous cracking (U. S. Pat. 1,598,805); Blumner, upon an arrangement by which it is possible to conduct the hydrocarbons for cracking, mixed with hydrogen, through a bath of fused metal (Ger. Pat. 439,712, supplementing No. 338,846); Owens, upon a process in which a mixture of steam and oil at cracking temperature is passed through a heated tube (U. S. Pat. 1,613,124); Kolksky, upon a process for accelerating both cracking and hydrogenation by using a suitable catalyst, namely, a metal haloid, such as iron chloride, and a mixture of ammonium chloride and finely powdered metal (U. S. Pat. 1,598,973); Page, upon a process which aims to avoid the separation of coke by cracking in a container inside the still with electrical internal heating (U. S. Pat. 1,597,476); Wolcott, upon a process by which the oil to be cracked is passed through a series of chambers at alternating high and low temperature, with the cool chambers charged with aluminum chloride (U. S. Pat. 1,601,421.)

Cracking

The Cracking of Gabian Petroleum by the Anyhdrous Aluminum Chloride Process. (*Andre Graetz. Ann. office nat. comb. liquides* 2, 69-91 (1927). *C. A. Nov.* 10, 1927, *p.* 3737.) On treating dehydrated and refined (with H_2SO_4 and NaOH) Gabian petroleum (which has an initial

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b.p. of 217 degrees) with increasing proportions of $AlCl_3$, the maximum yield (74.5 per cent.) of light products (distilling up to 210 degrees in the deLuynes-Bordas apparatus) was obtained with 9 per cent. $AlCl_3$, weight in volume. On the crude petroleum, the same degree of maximum cracking was obtained, but with 14-15 per cent $AlCl_3$, the increase in $AlCl_3$ consumption was due to the action of H_2O and of S and oxygenated compounds in the crude. On distilling the crude to 340 degrees and treating the distillate (without refining) with $AlCl_3$, the same maximum cracking was obtained with 12 per cent $AlCl_3$, because of evolution of considerable H_2S during distillation of the crude. Investigation of the formation of metal chloride complexes with petroleum led to the following conclusions: (1) Sniv, S, Hg," Cu," Fe"' and Na chlorides and bleaching powder form complexes with the cracking oil on heating for a suitable length of time; (2) these complexes are soluble in the Cl derivitives of CH_4, C_2H_6 and C_2H_4, in which all the H has not been substituted by Cl, and they are insoluble in the Cl derivitives in which the H has been completely substituted. (3) in order that cracking may be catalyzed by a metal chloride, the latter must be volatilized or decomposed between 190 and 210 degrees. The mechanism of the cracking may be considered as due to the formation of a hydrocarbon-metal chloride complex, which is decomposed at the distillation or decomposition temperature of the metal chloride, with a breaking up of the C chain into lower-boiling products. The minimum cracking temperature of oil is 160 degrees, and at 200 degrees the reaction is well started; the complexes formed by chlorides boiling at a lower temperature (e.g., SCl_2, $SnCl_4$) decompose before the minimum cracking temperature is reached; the complexes formed with high-boiling chlorides (e.g., $FeCl_3$) are very stable, so that cracking cannot take place below 250-60 degrees; the $AlCl_3$ complex is stable up to 180-90 degrees, at which temperature the oil liberated by decomposition of the complex can crack into lighter products. Investigation of the decomposition of the $AlCl_3$-hydrocarbon complex showed that at atmospheric pressure it begins at 150-60 degrees, is fairly active at 190-210 degrees and is complete at 230-40 degrees. It would therefore be preferable to carry out the cracking at 240-5 degrees. Because of limitations of the laboratory equipment used, the results obtained are less favorable than would be obtained on an industrial scale. Graetz considers that under ordinary circumstances the process could not compete economically with other processes (e.g., Dubbs'); but that it might be of considerable use in emergencies.

Treating

The Treatment of Cracked Benzine and Primary Tar Benzine with Sulfuric Acid and Liquid Sulfur Dioxide. (*Erdely and Almasi. Brennstoff-Chem. Nov.* 15, 1927, *p.* 358, *Libr. Bull., U. O. P. Co., Vol.* 2,

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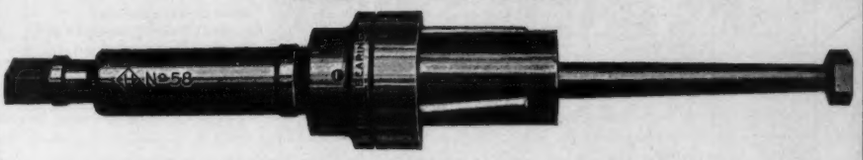

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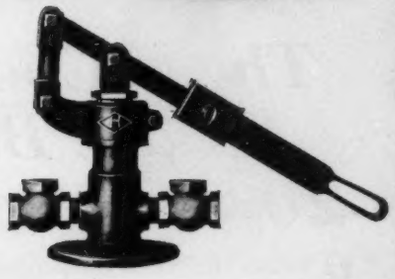
Tube Expanders for Steam Boilers
Screw Punches for Structural Shapes
Tube Expanders for Pipe Work
Screw Punches for Plate Work
Flaring Tools for Still Tubes
Beading Tools for Still Tubes
Hydraulic Jacks
Hydraulic Punches



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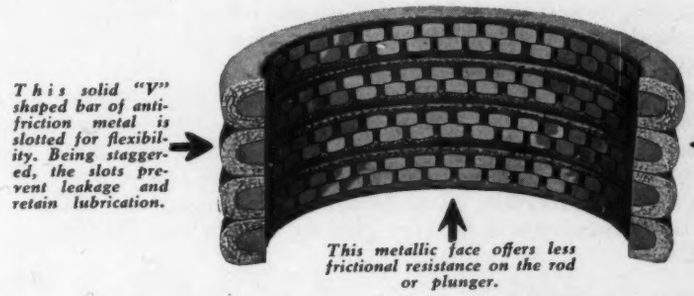

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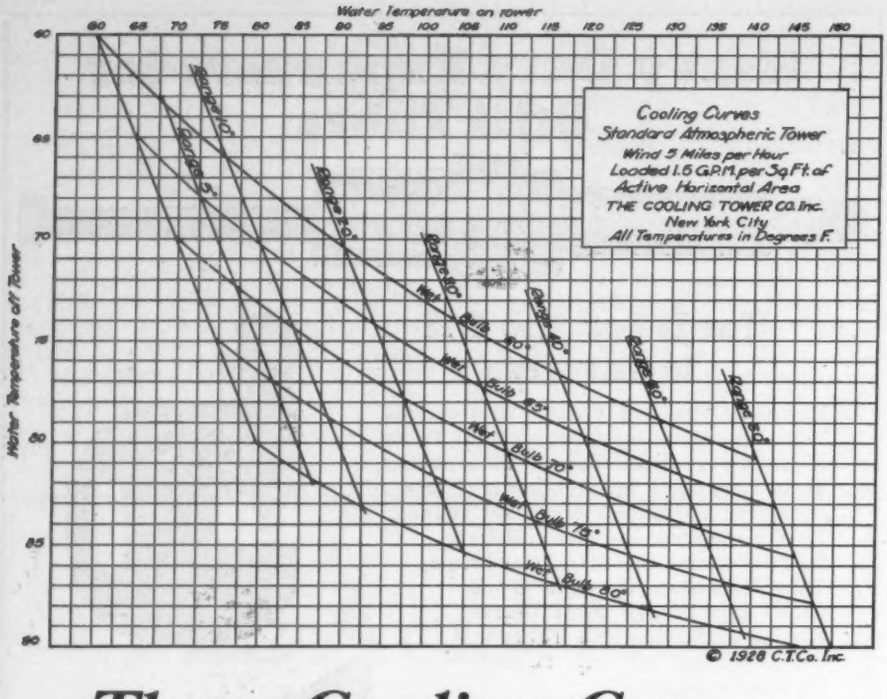

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No. 49, *pp.* 444-45. *No.* 50, *p.* 455.) It is now well understood that the objective in refining benzine is, not to remove all unsaturated compounds, but only those which resinify in the motor, cause corrosion, or darken on standing. To know what method of refining to adopt for a benzine, it is necessary to know what its composition is. A cracked benzine from Rumanian gas oil, another from Hungarian brown coal generator tar oil, and a third from brown coal primary tar were analyzed by the method of Resinfeld and Bandte (Erdol u. Teer, Mar. 1927). 250 c.c. of the benzine was distilled in a 300 c.c. flask and the end point and the residue, *a*, exactly determined. 250 c.c. of the benzine was shaken with 500 c.c. of 85 per cent. sulfuric acid and allowed to stand for several hours. The volume loss, A, the quantity soluble in the acid, was determined and the purified product distilled in the 300 c.c. flask to the end-point previously determined. The residue, *b*, was measured exactly; b—a=B, the quantity of the constituents polymerized by sulfuric acid. A + B is the whole amount of unsaturates in 250 c.c. of benzine. Fifteen c.c. of the residue, freed from unsaturates, was shaken in a measuring cylinder with 100 per cent. sulfuric acid. The volume loss represented the content of aromatics. The benzine was separated from the acid and washed with caustic solution and then with water, and this residue used for determining the aniline point. Ten c.c. each of the benzine residue and pure aniline were slowly heated with stirring till a homogeneous solution was formed.

This point was checked by noting the point in the falling temperature at which the thermometer was no longer visible as the mixture became turbid. The difference between 70 degrees and the temperature found, divided by 0.3, gave the percentage of naphthenes. The tabulated results show that the three cracked benzines were quite similar in composition.

Action of sulfuric acid of different concentration upon the benzines.

Ten, 20 and 30 per cent. acid scercely reacted at all. Above 40 per cent strength the darkening of the benzine on shaking with the acid was in proportion to the concentration of the acid. Between 50 and 60 per cent. the contraction began to be measurable; 70 per cent acid dissolved half as much material as 85 per cent.

Quantity of 85 *per cent. acid required.*

The maximum contraction could only be produced by the use of 150 per cent of 85 per cent acid; in many cases, 200 per cent. was necessary.

The percentage dissolved by 100 per cent. acid were always less than the sum of the unsaturates and aromatics by Riesenfeld and Bandte's method. This failure of the 100 per cent. acid was the more marked as the percentage of these constituents rose.

When the attempt was made to separate the saturated compounds from the unsaturateds and aromatics in the cracked benzines from Rumanian gas oil and brown coal generator tar oil, and in the brown coal primary tar benzine, by Edeleanu's process of treating with liquid sul-

fur dioxide at —12 degrees, no complete separation could be made. The refinate was always less than the sum of the paraffins and naphthenes determined according to Riesenfeld and Bandte; and yet it always contained from 6.7-11.6 per cent. of constituents soluble in 100 per cent sulfuric acid. The iodine numbers according to Hubl also gave evidence of the presence of unsaturates in the refinate. The extracts on the other hand contained only 35.7-51.0 per cent. of unsaturates; of the total extract they constituted less than half. But the refinates were specifically lighter and poorer in unsaturates, while the extracts were heavier and richer in this class of compounds than the original benzine fractions. Liquid sulfur dioxide, however, in every case gave a water-white stable extract of agreeable odor; and it has the advantage over the sulfuric acid treatment that the extract can be recovered chemically unchanged. There is a prospect therefore that the process of Edeleanu will find application in the refining of cracked benzines. The primary-tar benzine could not be separated, even with a 200 per cent. excess of sulfur dioxide, into two layers at —12 degrees. According to Klein this might have been done at —60 degrees. The smaller the quantity of unsaturates and aromatics, the better the separation with sulfur dioxide. When these compounds form 70 per cent. of the whole, no separation is possible at —12 degrees.

Filtration

Silica Gel as Adsorbent for Sulfur Oils from Petroleum. Woodward. (*Presented at St. Louis Meeting A. C. S., April* 16-20, 1928. *Libr. Bull., U. O. P. Co., Vol.* 3, *No.* 17.) A commercial gel and a special gel from H. N. Holmes were brought in contact with high sulfur crude oil, either by filtering the oil through the gel or by stirring the gel with the oil diluted with naphtha. The adsorbate was stripped by washing with several organic solvents, such fractional washing removing about 93 per cent. of the adsorbed material, and the remainder being obtainable by dissolving out the gel with alkali. Every fraction so obtained had a higher sulfur content than the original oil. Benzene gave back an oil containing 5.65 per cent. sulfur, compared with 2.6 per cent. in the original oil. This fraction re-adsorbed, gave a new fraction with 8.7 per cent. sulfur.

Commercial silica reduced the sulfur content of a crude oil from 2.3 per cent. to 1.9 per cent. It removed 18 per cent. of the sulfur from a naphtha solution, while the Holmes gel removed 36 per cent., also removing color.

Wax Manufacture

X-Ray Studies of Paraffin Wax and Their Practical Significance. Clark. (*Paper presented at Swampscott meeting of American Chemical Society, Sept.,* 1928.) Detailed X-Ray diffraction data on the normal aliphatic hydrocarbons in both the solid crystalline and liquid states are presented. In thin layers the molecules arrange themselves parallel to each other and form equidistant layers whose

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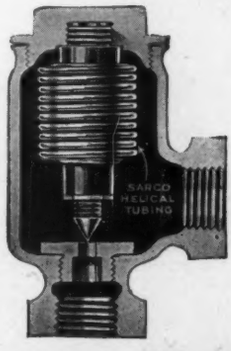

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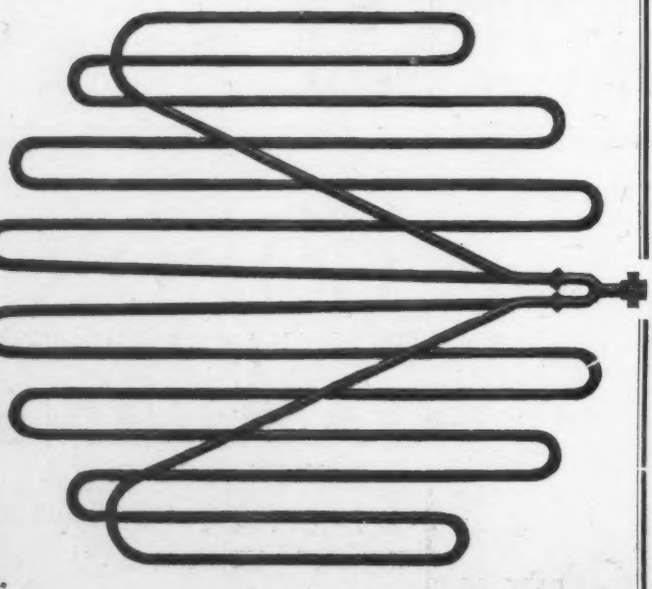

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spacing is a measure of molecular length. This spacing is a linear function of the number of carbon atoms. In single crystals of the lower hydrocarbons at least two crystalline forms are found in which different tilts of the molecules to the diffracting planes are found. In liquids no diffraction maxima are found, contrary to the results with alcohols, acids, and compounds with polar end groups.

2. Paraffin wax, though a mixture of many normal hydrocarbons, yields diffraction lines characteristic of only one spacing corresponding to a pure component which may be present in small quantities. Data are presented to show how this spacing is a function of melting point, source of wax and composition, and for a given wax upon the rate of crystallization. Data on narrow cuts indicate interesting progressions by no means linear or simple.

3. The effects of small amounts of addition agents such as acids, soaps, dyes, amines, etc., on the long spacings are in general to increase the value, except for acids or soaps which impress their own spacing on the more weakly orienting hydrocarbon molecules.

4. The relationship between the X-Ray data and some of the important properties, particularly grain size, moisture penetrability and transparency is such as to simplify practical problems and specifications. Preliminary data in this field are presented chiefly to show the great value of further intensive and co-operative researches.

OF PARTICULAR INTEREST TO THE REFINERY AND CHEMICAL ENGINEER

An Investigation of the Corrosion of Metals with a Thermobalance. Kenzo Inamura (Science Reports of the Tohoku Imperial University, Sendai, Japan, First Series, Vol. 16, *No.* 8, *Dec.* 1927, *pp.* 987-97. *Mech. Eng., Vol.* 50, *No.* 3, p. 233.) In investigating the corrosion of metals the usual method consists either in microscopic or miscroscopic observation of the metal surface, or in suspending the specimen in a certain corroding solution for a given interval of time, the corrosion products being then removed and the corrosion loss determined by means of an ordinary balance. There has as yet been no attempt made to follow attentively and without interruption the change in weight of the metal during the progress of the corrosion. In the present work the thermobalance, which was originally devised by Dr. K. Honda, was used for the continuous observation mentioned above. It is well known that this thermobalance has been used very effectively in observing the change in weight accompanying chemical changes. The article under consideration here contains the results obtained in the present investigation which was carried out under the direction of Professor Honda.

For this purpose a kind of thermobalance was made from an ordinary chemical balance. The specimen was a com-

mercial iron sheet and the corroding solutions consisted of the following seven reagents of various concentrations: water, sodium chloride, sodium carbonate, sodium bicarbonate, sodium nitrate, sodium sulphate and potassium hydroxide, the experiments being carried out at 45 degrees centigrade.

Generally, in these solutions the iron corrodes with the formation of flocculent and easily detachable ferric bicarbonate solutions; in this case a gelatinous corrosion product was formed on the metal surface and could not be detached easily, and the weight of the sample was increased continuously. Owing to the formation of hydrogen-gas bubbles on the metal surface, continuous measurement could not be carried out in acid solutions.

Underground Pipe-Coating Materials. (*Chem. and Met. Eng., Vol.* 34, *No.* 12, *p.* 743.) As a part of the report of a subcommittee on pipe coatings, rendered at the American Gas Association meeting in Chicago, October, 1927, there was given the following statement of the characteristics of a good material for coating mains and service pipes to minimize corrosion damage:

(a) The coating material should be impervious to air and moisture.

(b) It should adhere tenaciously to the surface of the pipe.

(c) It should not be brittle at 0 degrees Centigrade (32 degrees Fahrenheit) or soften to such an extent at 60 degrees Centigrade (140 degrees Fahrenheit) that it will run or rub off during handling.

(d) It should withstand, without chipping or spalling off, the shocks and abrasion to which the pipe is likely to be subject during transportation and installation.

(e) The coated pipe should not stick together during transportation.

(f) The material should be easily applied either in the yard or in the field.

(g) The material should be of such a character that any damage occurring in the field can be readily repaired after installation.

Thermal Properties of Petroleum Products. (*Cragoe. From a paper given at the Richmond meeting of the A. C. S., April* 11-16, 1927. *Libr. Bull., U. O. P. Co., Vol.* 2, *No.* 18, *pps.* 134-35.) Mechanical engineers have "steam tables" and refrigerating engineers have "ammonia tables," but petroleum engineers have no analogous tables to guide them toward advancements in processes and in design of equipment. A critical review of the scattered data in the literature and unpublished data obtained at the Bu. Stds. on such properties as thermal expansion, thermal conductivity, heat of combustion, specific heats, and latent heats, indicate the following:

(1) The thermal properties of the various petroleum products are remarkably similar, many properties varying systematically with density.

(2) Existing data on some properties are of ample accuracy for most engineering purposes; experimental work on others is most desirable.

(3) "Petroleum tables and charts of

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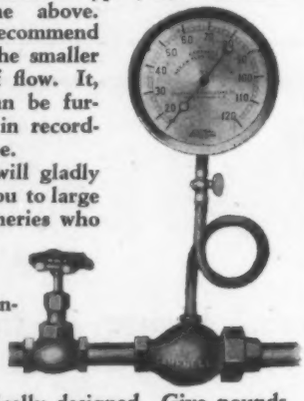

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thermal properties" in convenient form for practical use are a real possibility.

OF PARTICULAR INTEREST TO THE CHEMIST

Testing and Analysis

Variable Compression Engine for the Examination of Liquid Fuels. (*Oberle. Petr. Zeitscher., Jan.* 10, 1927, *J. I. P. T., Apr.* 1927, *Abs. No.* 205.) A single-cylinder engine is described, so arranged that by movement of the cylinder vertically the compression ratio can be varied, while running under full load, between 2:1 and 9:1, rated at 4 horsepower, 550 r.p.m. The power generated is absorbed in a lamp resistance. The method of examining petrols for their respective points of incipient detonation is outlined. Graphs are given showing the power output with increasing compression ratio when different petrols are used; the power output in each case attains a maximum. The less easily a petrol detonates the higher the maximum power output obtainable, other conditions being equal. Several indicator cards of explosion under detonating and non-detonating conditions are illustrated.

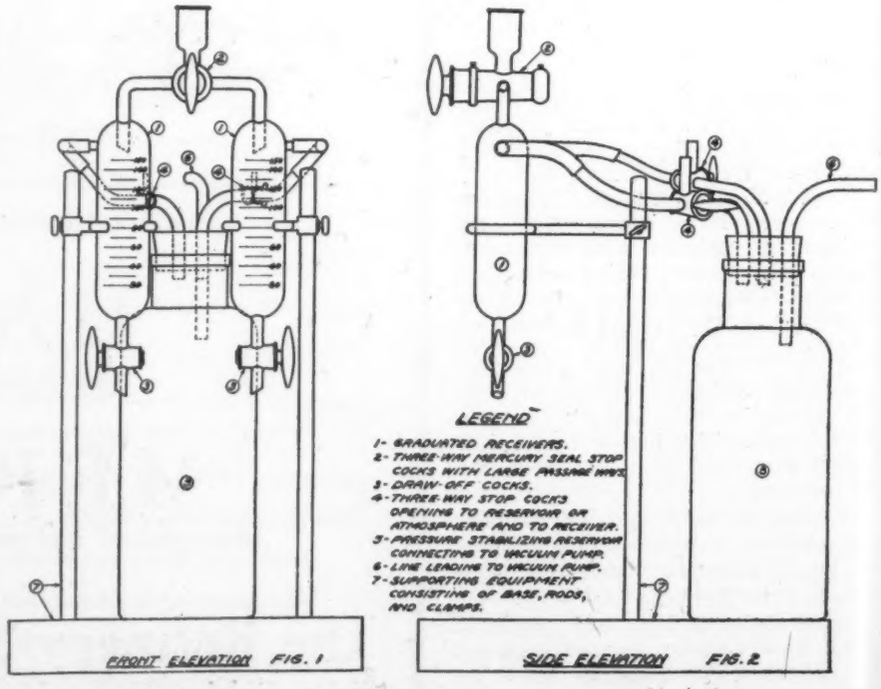
A New Method of Rating Fuels According to Ease of Detonation. (*Jour. Soc. Auto. Engrs., Feb.* 1927, *p.* 184. *Libr. Bull., U. O. P. Co., Vol.* 2, *No.* 9, *pps.* 62-63.) Faragher and Hubner describe a new apparatus and practical method for rating fuels as to their tendency to detonate. One hundred samples can be tested in a day and tests of the same sample made at different times agree well. One hour is sufficient to prepare for operation after a period of disuse, and the apparatus can be used for 20 hours before reconditioning. Degree of knocking is shown by a modified bouncing-pin indicator. The motor fuels are matched with blends of benzol and selected straight-run Pennsylvania gasoline. The intention is to standardize these blends by pure heptane and pure octane, as proposed by Dr. Edgar.

Apparatus for Fractional Distillation Under Reduced Pressure. (*Morrell and Egloff. Ind. and Eng. Chem., Vol.* 19, *No.* 11, *p.* 1292.) The authors state that several years ago they described a new form of apparatus for the fractional distillation of liquid mixtures under reduced pressure, same having been published under the title of "Fractional Distillation of Various Petroleum Hydrocarbons Under Reduced Pressure." The present paper relates to a modification of this apparatus. The construction and operation of the apparatus is described. The description of the apparatus is made more clearly understood by an accompanying drawing.

Results of Research and Investigational Work

The Light-Oil Residues of Oil-Gas Tar from Solar Oil (*Gas-Oil*) *and from Raw Naphtha. Pyhala.* (*Erdol u. Teer* 4, 146-9, (1928). *C. A., Vol.* 22, *No.* 11, *p.* 2049.) The distillate and distillation residue from the Solar-oil residue resembled those from raw turpentine oil in physical and technical properties. The yield and properties were improved by treatment with floridin. These products were absent in the Baku oil residue which yielded, instead, considerable quantities of marketable naphthalene, the yield of which was trebled by distilling under partial decomposition conditions.

Artificial Petroleum. (*A. Mailhe. Bulletin de la Sochiete Chimique, Aug.*, 1927, *pp.* 1056-61. *Chem. and Met. Eng,, Vol.* 34, *No.* 11, *p.* 696.) By distillation of Japan wax or carnauba wax in the presence of


LEGEND
1- GRADUATED RECEIVERS.
2- THREE-WAY MERCURY SEAL STOP COCKS WITH LARGE PASSAGE WAY.
3- DRAIN-OFF COCKS.
4- THREE-WAY STOP COCKS OPENING TO RESERVOIR OR ATMOSPHERE AND TO RECEIVER.
5- PRESSURE STABILIZING RESERVOIR CONNECTING TO VACUUM PUMP.
6- LINE LEADING TO VACUUM PUMP.
7- SUPPORTING EQUIPMENT CONSISTING OF BASE, RODS, AND CLAMPS.
FRONT ELEVATION FIG. 1
SIDE ELEVATION FIG. 2

Apparatus for fractional distillation under reduced pressure

zinc chloride, hydrocarbons closely resembling petroleum can be obtained. They can be separated into gasoline, kerosene, heavy oil and paraffin fractions; and the higher fractions can be cracked to form light oils and hydrocarbons, even down to methane and ethylene. Further distillation, accompanied by cracking and re-polymerization leads to carbon-rich oils and, finally, to pitch.

Dielectric Constant of Petrols and Paraffins. (*Pecheux. Compt. rend.* 183, 530 (1926). *B. C. A. -B, Dec.* 10, 1926, *p.* 971.) The dielectric constants and their temperature coefficients, and the melting point and boiling point of six petroleum oils and three paraffins were determined. For liquid petrols and heavy paraffins respectively, the temperature coefficient, which is negative, increases and decreases in absolute value with the dielectric constant. In both cases the dielectric constant increases with the density. For paraffins the value of the temperature coefficient is one-half to one-third of that for liquid petrols.

Mechanical Design and Detonation. Ricardo. (*Automobile Engineer, Vol.* 18, *No.* 237, *January,* 1928, *pp.* 23-24.) Question of detonation in its relation to engine design; what could be done in way of performance considered if detonation were non-existent; advantages and disadvantages of raising compression ratio; tendency to detonate depends upon four design factors; influence of turbulence upon detonation; effect of cylinder size on detonation. Paper presented at meeting of Petroleum Technologists.

Ricardo Discusses High Compression Engines. Ricardo. (*Automotive Industries, Vol.* 58, *No.* 6, *Feb.* 11, 1928.) Mean temperature during firing stroke lowered very considerably owning to longer expansion; compression ratios most suitable were fuel obtainable which would not produce detonation under any conditions; combusion chamber design from standpoint of detonation; experiments made with sleeve-valve engines.

Interpretation of Exhaust Gas. Minter. (*Jour. S. A. E., Vol.* 21, *No.* 5, *Nov.* 1927, *pp.* 573-75.) Author explains chemistry involved in combustion in effort to arrive at more accurate knowledge of constituents of exhaust gas; sets forth simple stoichiometric relations that exist between products of combustion of hydrocarbon fuel; correction factors that must be introduced in applying these ideal relations to combustion under actual engine conditions.

Physical Characteristics of Lubricating Oils. Anon. (*Oil Eng. Tech.* 8, 342-3 (1927). *C. A., Vol.* 22, *No.* 1, *p.* 160.) It is suggested that the "oiliness" of lubricating oils may be due to the formation of carbides of the metals or that the colloidal properties of the oil permit the filling of holes in the metals by colloidal particles and thus reduce the friction.

How Lubricating Oil Can Retain Its Youth. Oldham. (*Power, Vol.* 66, *No.* 21, *Nov.* 22, 1927, *pp.* 788-791.) At least three problems are involved in the lubrication

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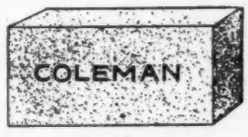

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of oil-engines; one is method employed, another is selection of suitable grade of oil, while the third is the manner in which the oil is handled; lubrication within crankcase; trunk-piston engine lubrication; carbon troubles.

The Lubrication of Surfaces Under High Loads and Temperatures. (*Stanton. Engineering, Vol.* 124, *No.* 3216, *Sept.* 2, 1927, *pp.* 312-13. *Mech. Eng., Vol.* 49, *No.* 11, *p.* 1280.) Investigation carried out at Nat. Physical Lab. show oils which possess exceptional lubricating properties under boundary lubrication conditions are not necessarily best for purposes of film lubrication, and vice versa; in search for a lubricant which will enable a machine to be run at really high temperatures and at high efficiency it is not only chemistry of lubricant, but its physical properties, which must be studied.

The Viscosity of Lubricants at High Pressure. (*Engineering, Vol.* 125, *No.* 3243, *March* 9, 1928, *p.* 281.) Review of investigation by National Physical Laboratory in hope that light might be thrown upon reason for relative inferiority of mineral lubricants, as compared with those of animal and vegetable origin; contrary to expectation, viscosity of mineral oils was found to increase more rapidly than that of their rivals.

Lubricating Machine Tool Bearings. Horner. (*Can. Machy., Vol.* 38, *No.* 21, *Nov.* 24, 1927, *pp.* 15-18.) Discusses and illustrates variety of ways in which machine-tool lubrication may be accomplished for preservation of bearing surfaces against frictional deterioration or seizure.

Economics of the Crude Oil Engine Plant. Dodd. (*Commonwealth Engineer, Vol.* 15, *No.* 2, *Sept.* 1, 1927, *pp.* 54-56.) During past five years considerable progress has been made in Australia in connection with installation of crude oil engine plants; these installations have been mainly for generation of electrical energy.

New Processes

Conversion of Ethylene and Its Homologs into Oils. Otto. (*Brennstoff-Chem.*, 8,321-3 (1927); *C. A. Vol.* 22, *No.* 8, *p.* 1465.) Otto polymerized iso-butylene rapidly at its boiling point in the presence of 10 per cent boron fluoride, obtaining an oil 50 per cent. boiling 200 to 300 degrees C. Propylene gave similar results at room temperature, high pressure being required. With ethylene, starting at 130 atmospheres the conversion after eight hours was: at room temperature, 85; 100 degrees, 37; 200 degrees, 60; 300 degrees, 73; 0 degrees, 10 per cent. Catalytic nickel greatly promoted the reaction. The oils compared favorably with petroleum lubricating oils, particularly as regards viscosity and its temperature coefficient.

REFINERY AT MEMPHIS

With the acquisition of a 1000-barrel plant in Memphis, Tennessee, the Urania Petroleum Company, an English concern, has entered the refining phase of the industry. The plant is now running around 600 barrels of Seminole crude per day. It consists of one pipe still and four shell stills with fractionating towers. Anthony Gibbons is president and manager of the Urania Petroleum Company.

The company disposed of its remaining interest in Urania, Louisiana, production just before acquiring the Memphis refinery, and now proposes to reenter the producing business. It has assembled a block of leases in Adair County, Kentucky, on which it will start drilling in the near future.

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